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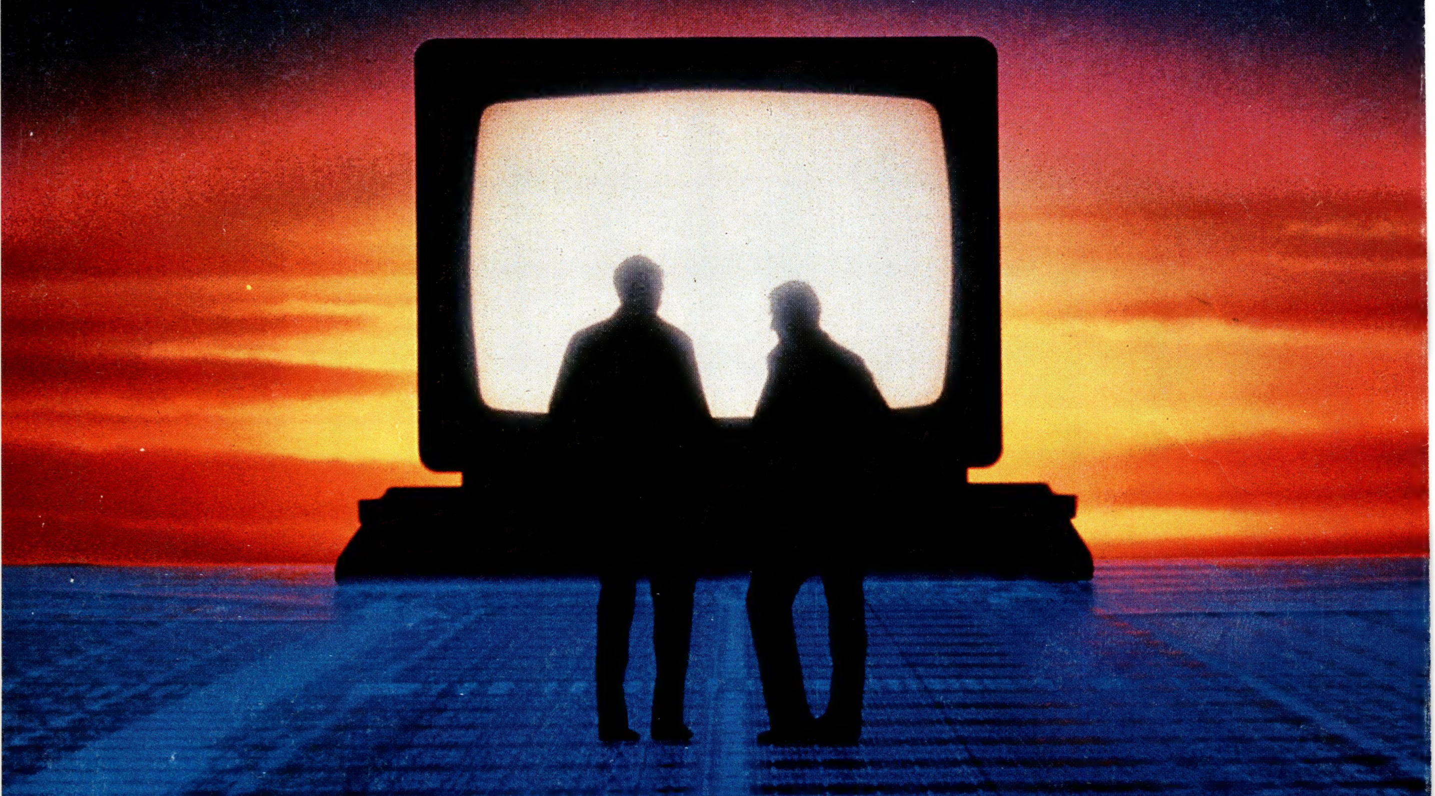
# GUIDEPOSTS FOR THE 90s



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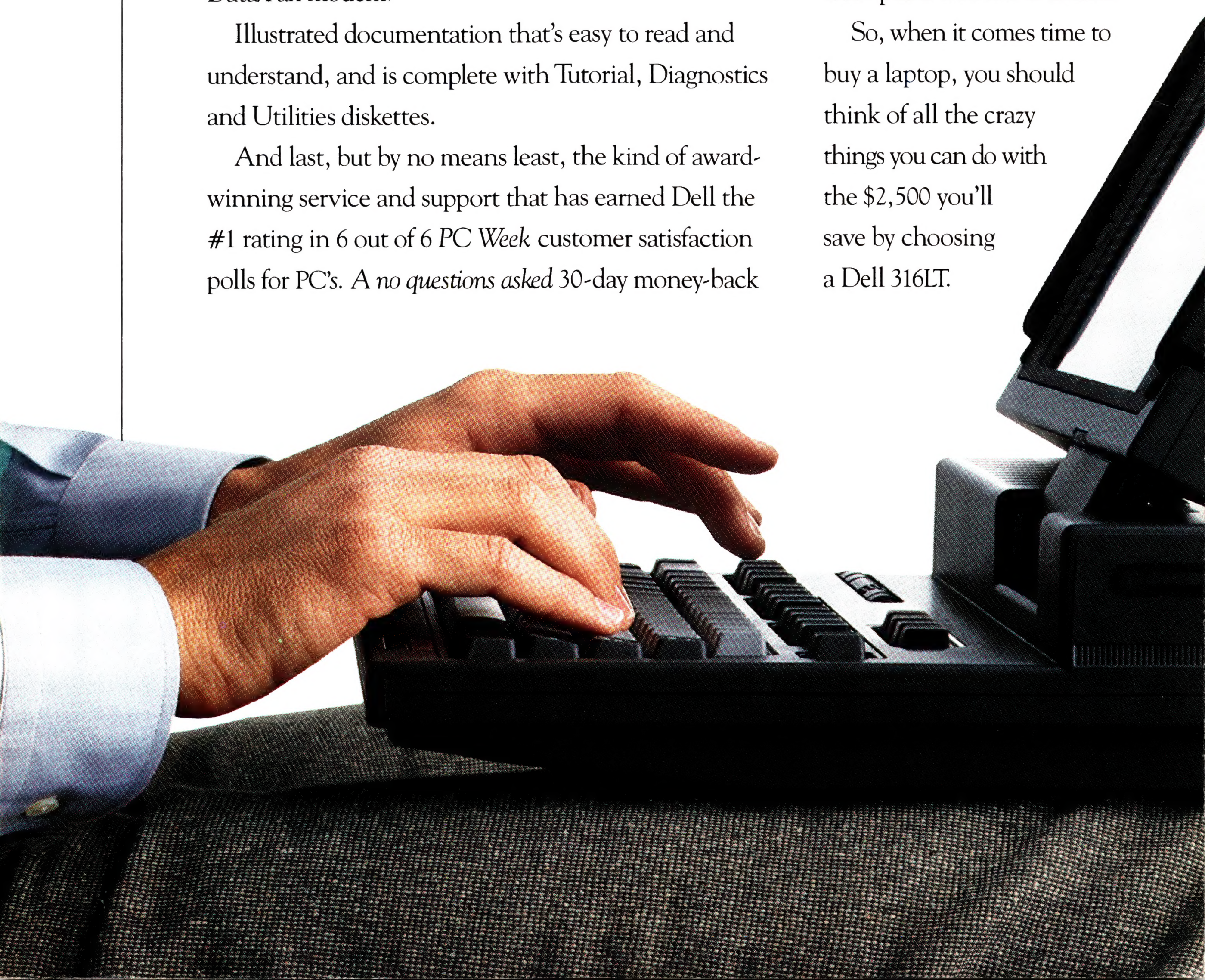

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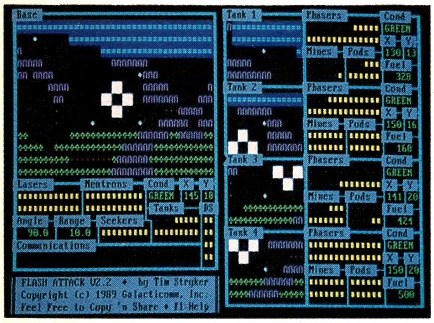

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| *Entertainment C source extensions** .. | $ 129 |

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| | |
|---|---|
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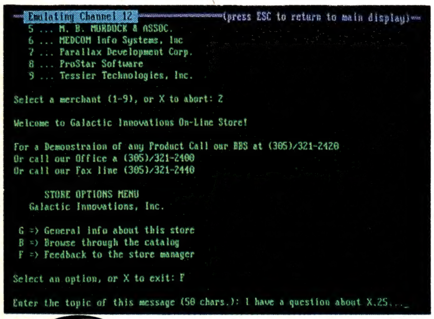
| *Shopping Mall C source extensions**. . | $ 189 |



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|---|---|
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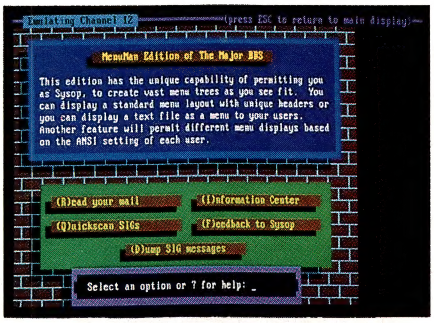

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              MenuMan Edition of The Major BBS

   This edition has the unique capability of permitting you
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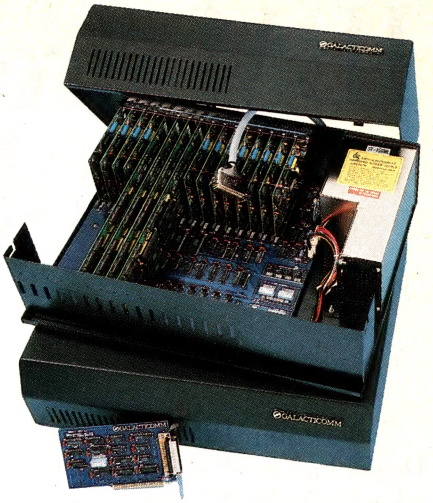

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**The C source code extensions are necessary, if you wish to combine multiple extended Editions together, or add 3rd-party software, or develop your own modifications. Prerequisites, in each case, are the Standard Edition C source code, and the corresponding extended Edition.*

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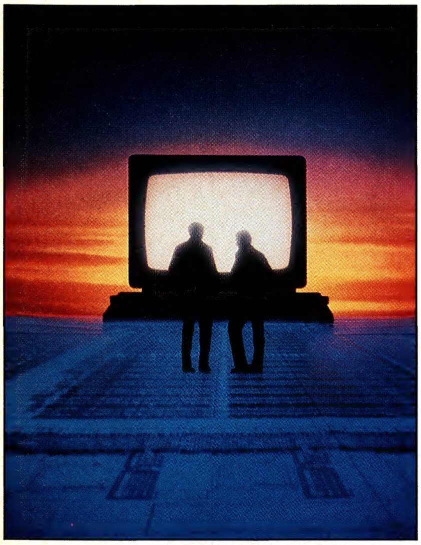

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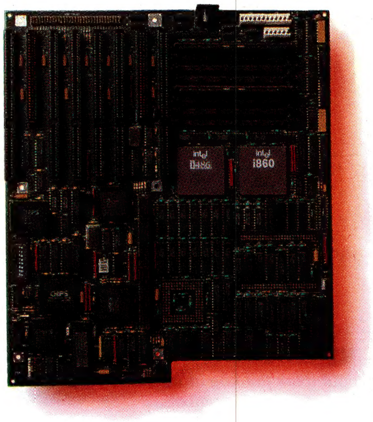

**A PC Revolution.** In the PC environment, the 4860 is a 486-based MotherBoard which runs over 2 times faster than 386 computers. It's fully compatible with DOS, IBM's OS/2, Novell Netware and UNIX. What's more, Hauppauge's 4860 supports up to 64 MBytes of memory *without* a RAM expansion board!

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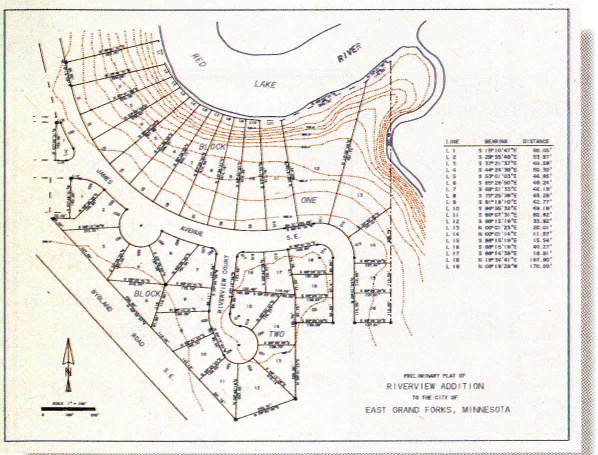

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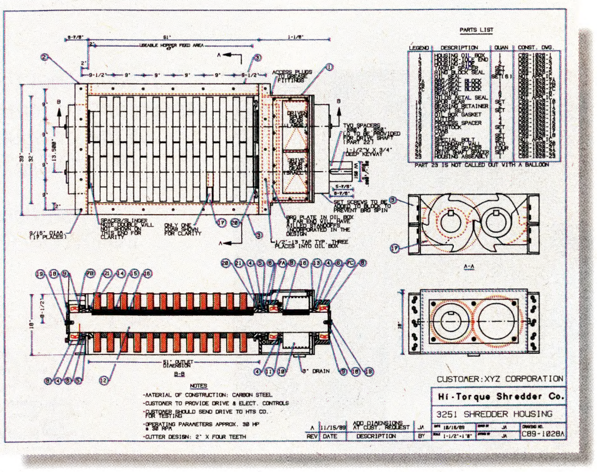

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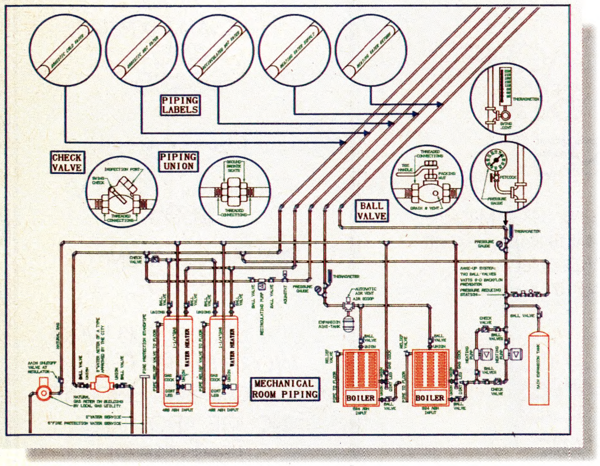

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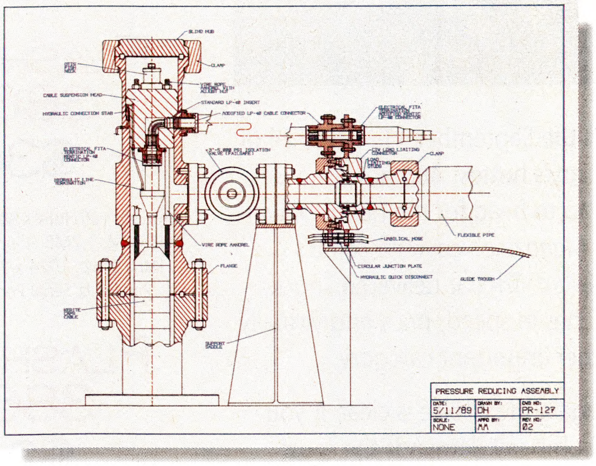

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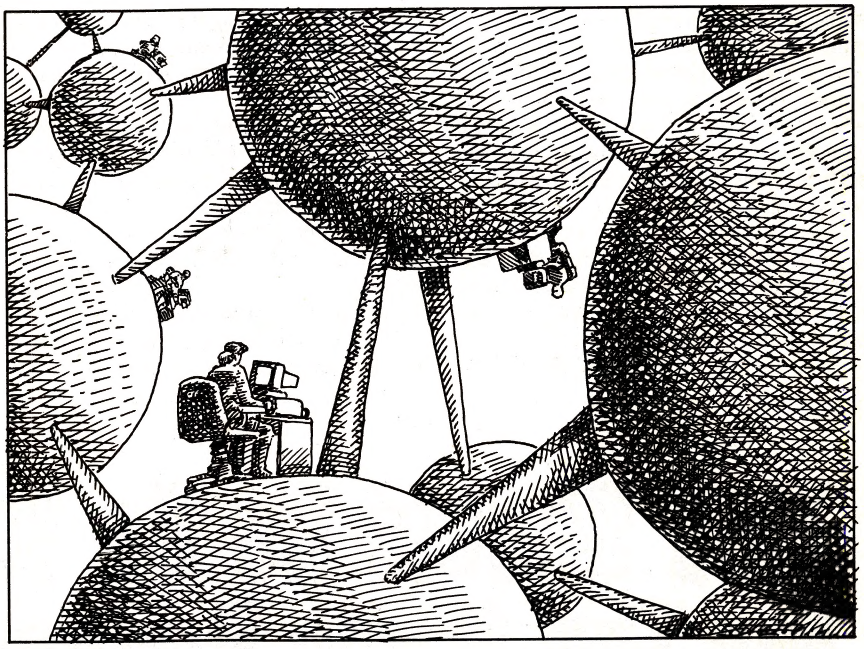
*Linking all the computers at Chaos Manor is a daunting task*

# CASTING A CHAOTIC NETWORK



I think this is a first. Certainly I don't usually make shareware my lead item, but this time it's appropriate, since I usually look at some aspect of the state of the art in the annual IBM issue, and this is certainly state-of-the-art shareware.

If you happened to see *The Hunt for Red October*, you may have noticed a peculiar display on the wall behind the admiral: a Mercator world chart, with an odd curved shape of light and shadow splashed across it. It is, in fact, a clock, and quite authentic; just about every senior CIA officer has one. What it shows is which areas of the world are in light and darkness just at the moment. Naturally, those responsible for controlling the U.S. spy satellites find this interesting.

The odd curved shape, representing the parts of the world that are in sunlight, changes over the course of the year, being concave southward when it's summer in the northern hemisphere, and concave northward when the sun travels south.

There was a clock like this in the science room of the Los Angeles Public Library. That clock was electromechanical, and it worked by moving the Mercator map on a continuous strip. I don't know how accurate it was. I always wanted one, but I found that the cost was higher than I cared to pay.

Now I have one, and it's better than the original.

## Geoclock

Geoclock is a computer simulation of the mechanical clock. I have seen only the EGA and VGA versions, but I understand there's a CGA version as well. In EGA it's plain gorgeous, and I often put it up on the 19-inch Electrohome monitor just to have it as eye candy in the Great Hall.

The shareware version is plenty good enough, but when you send in your $30 registration, you get a new version with a whole raft of extra features. Some, such as city names, I don't much care for, but most of that can be turned off. One warning: the program needs to be installed, since it comes with compressed files; but, unfortunately, it won't install from the B drive. It happens that I got 5¼-inch floppy disks, and the A drive of the Zenith 386/33 that drives the Electrohome monitor is a 3½-inch drive, so I had to copy the 5¼-inch floppy disks over to 3½-inch floppy disks. That worked fine.

I'll have a downloadable copy of the shareware version in my BIX conference, but my advice is not to bother with it; send the $30 and be done with it. It's inconceivable that you won't like this program. The graphics are great; every check I can make on the accuracy of the sunlight shape indicates that the programmer has it spot on; and there's even a little circle to indicate the exact spot that the sun is over at any given time.

Try Geoclock; you'll like it. It definitely gets a User's Choice Award. Highly recommended.

## High End and Low End

It's understandable that most writers like to talk about high-end stuff. I know I do, because that's where the fun is. My latest toys are a Cheetah Gold 486, with a Perceptive Solutions disk drive controller and 15 megabytes of memory. It's so fast, it scares me. If that weren't enough, there's the Premier 9000 and an Arche Rival 33-MHz 386 system with a 300-MB hard disk drive and a tape backup unit. These machines rival anything on the market, and they're fun.

There's a point to writing about high-end equipment: we help drive the industry. Brit Hume, in a recent essay, says this is a conflict of interest. I don't see it that way; what possible conflict of interest have I? I don't own high-tech stocks, and I already have more computer equipment than I need. More than I want. Nearly more than I can endure. There's not *room* for much more. I can't sell the

*continued*

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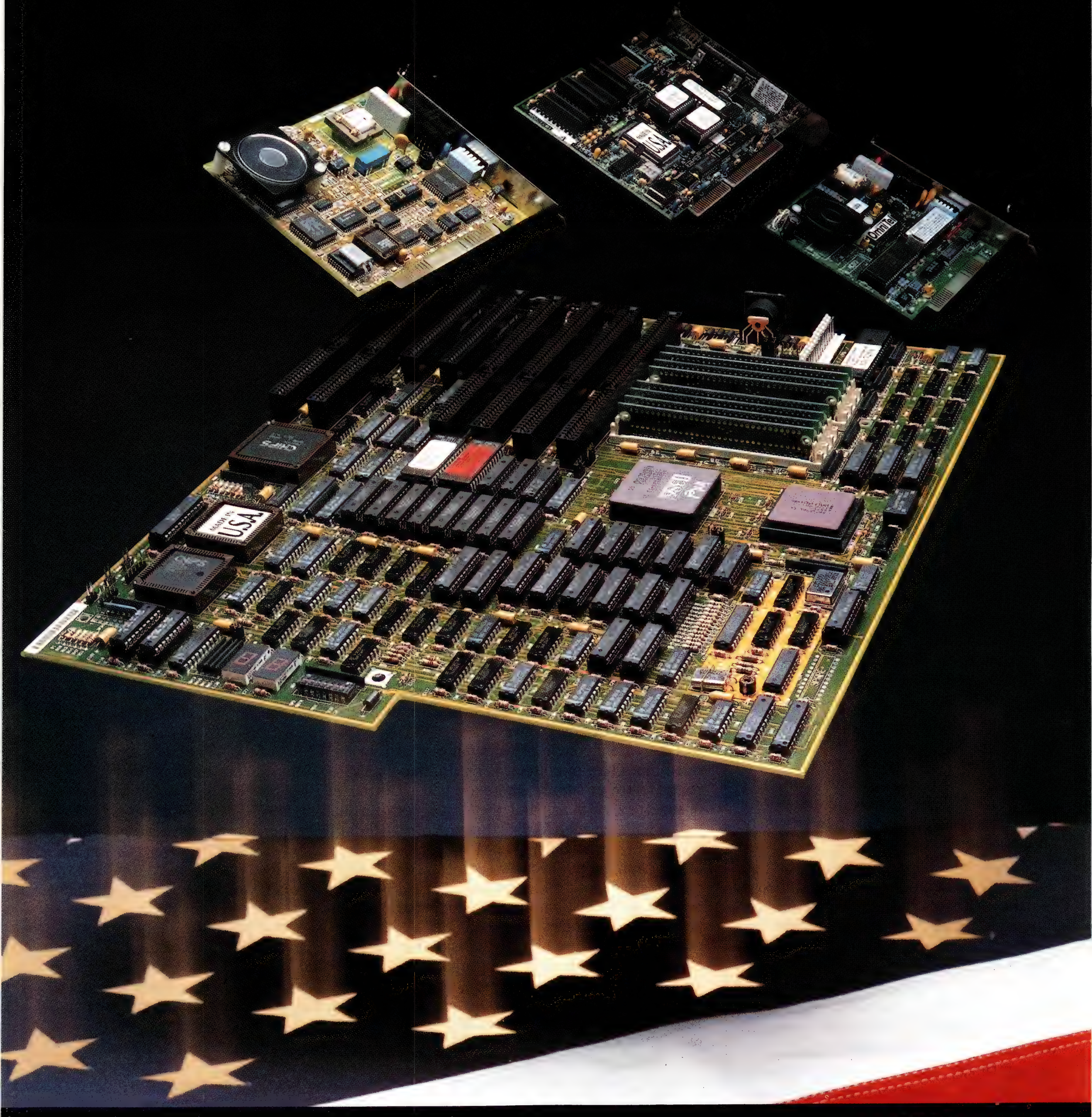

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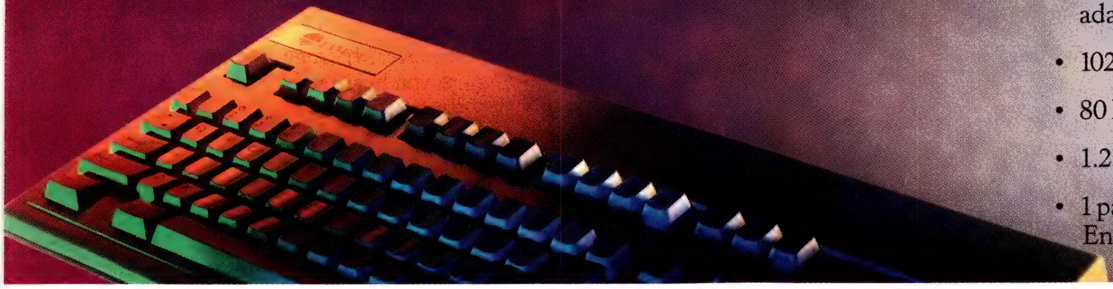

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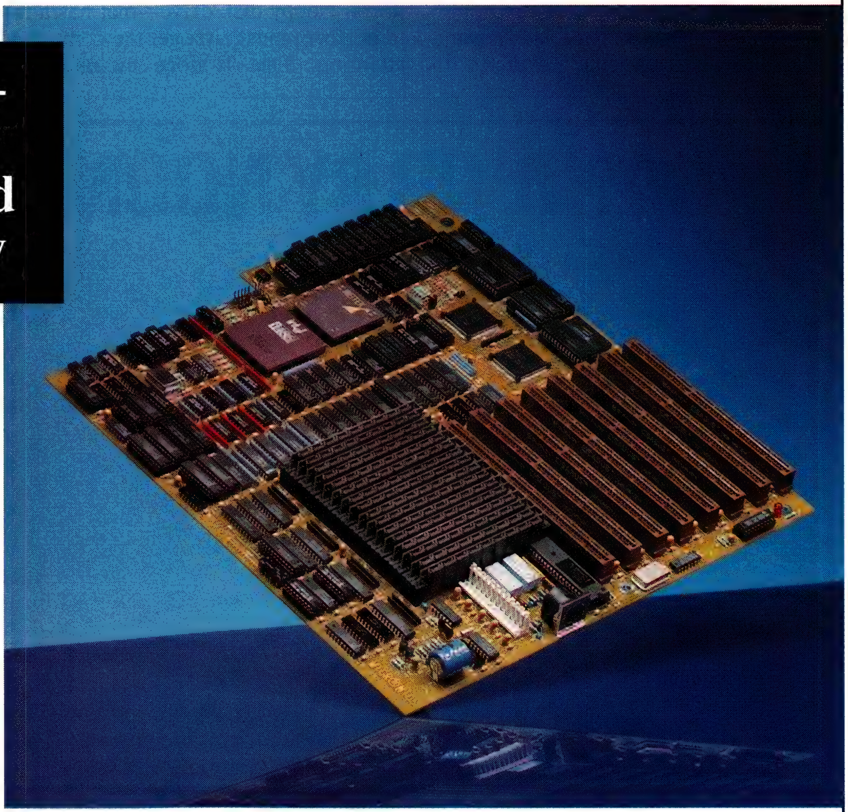

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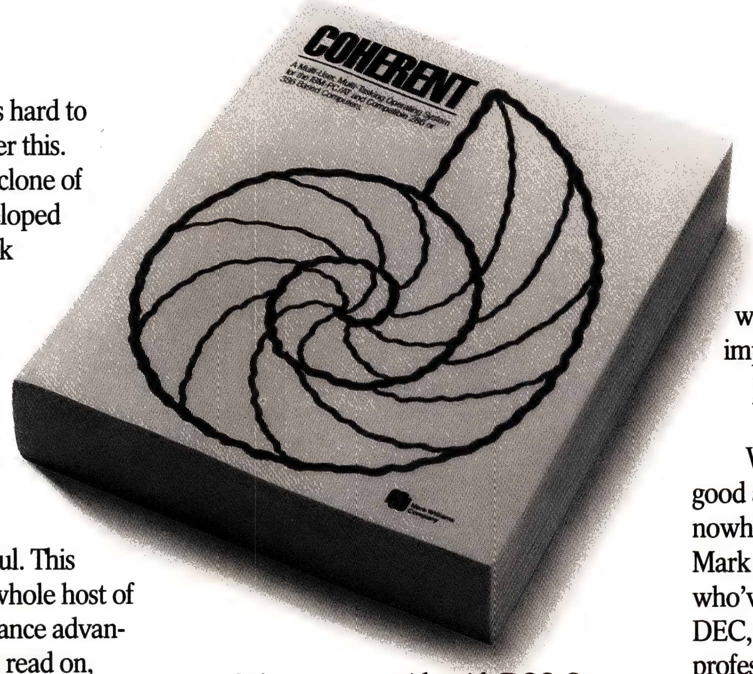
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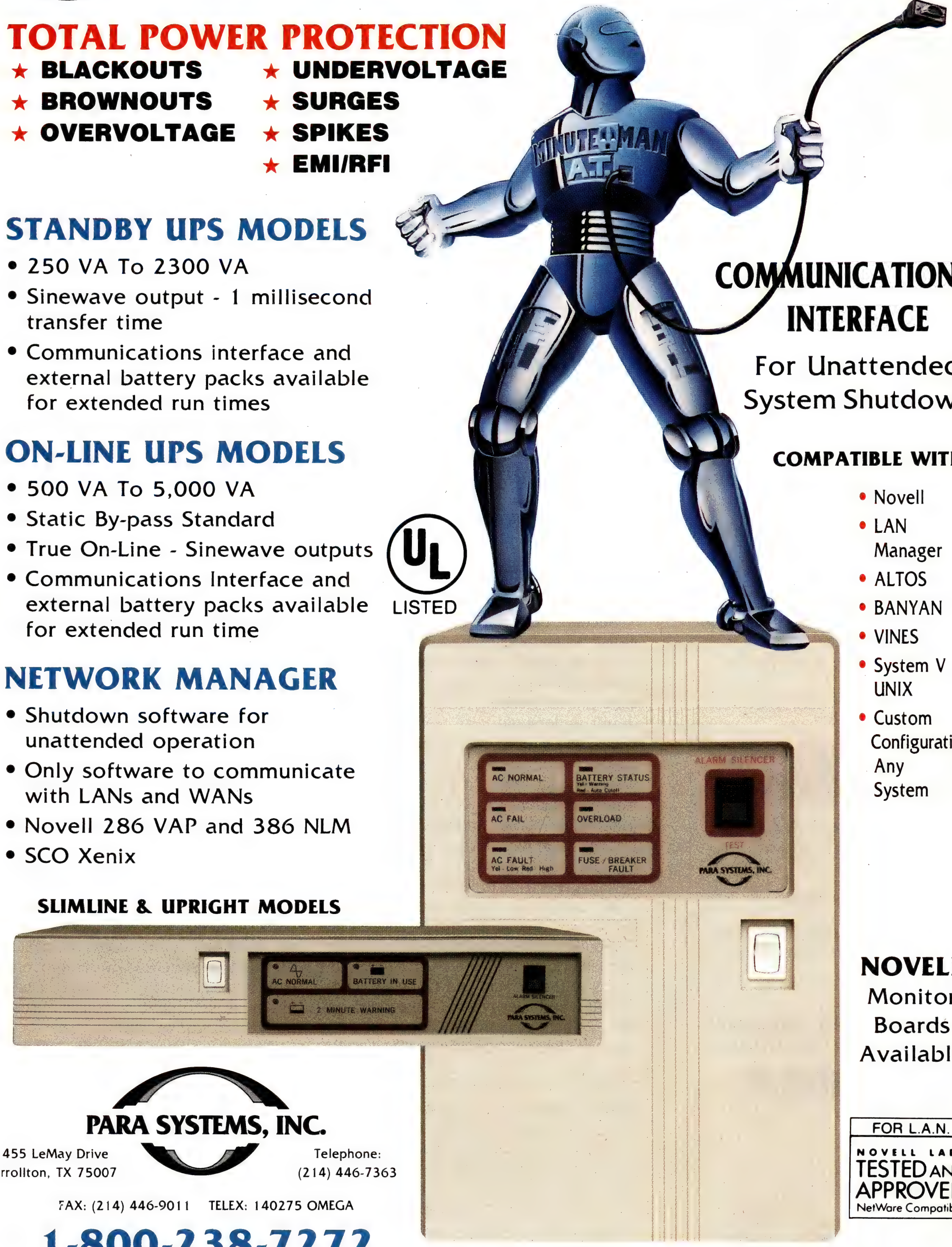

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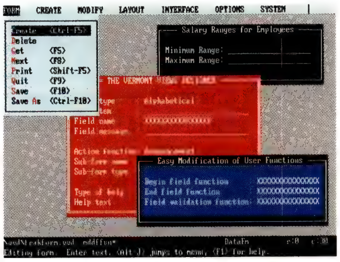

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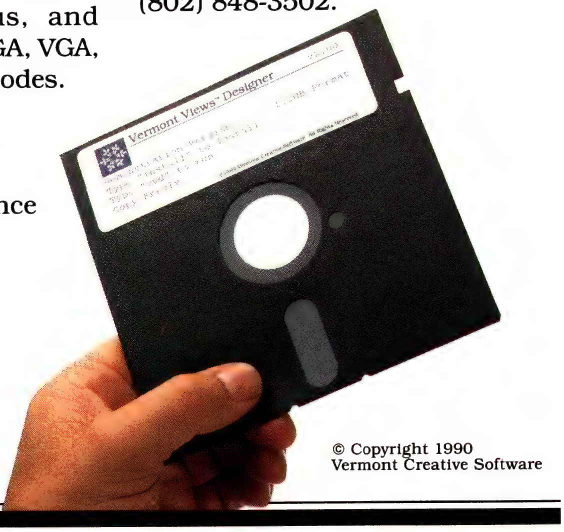

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*A few OS/2 products let your spreadsheet talk SQL*

# MONEY, SQL, AND SPREADSHEETS

A client (a bank) approached my company for help with something called "SQL" that it had heard would solve all its data-sharing problems. "We've got a little problem, and we're wondering if you can help us."

There were, it turned out, a few stumbling blocks.

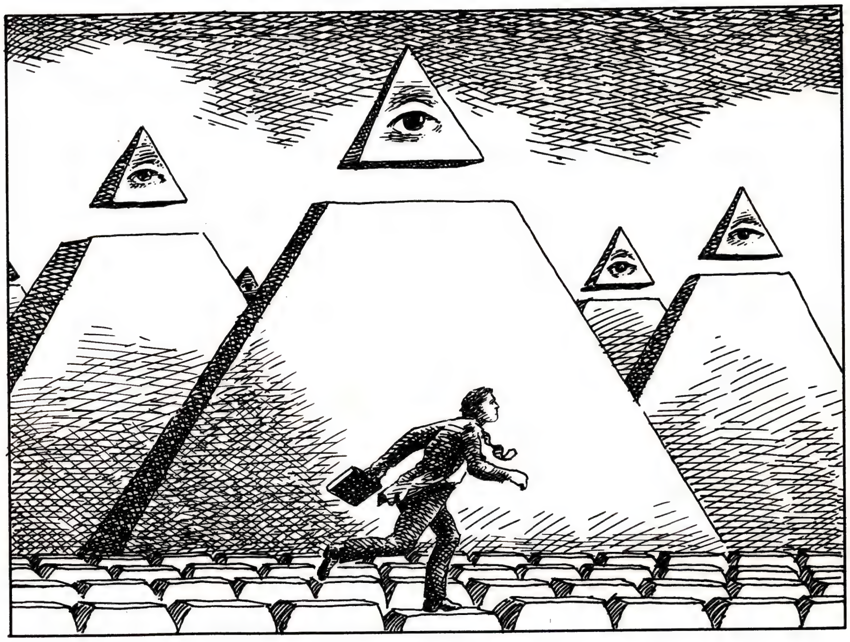
Like many firms, this bank relies heavily on Lotus 1-2-3. And, again like many firms, it has data at a centralized point (originally a mainframe, but it's moving to a LAN with a souped-up PC server) that it needs to get *into* 1-2-3.

Finally, like too many firms, it already has a kludgy solution: Download some data, run it through a program to massage it, and import it into 1-2-3. The bank had heard that Structured Query Language could help. That's where I came in, to determine which SQL-based product to buy and how to get 1-2-3 to talk to it.

One approach is to use a client program written in C, Pascal, COBOL, or any other language that can communicate with the SQL server by way of a SQL support library. (Generally, the database lives on the server machine, and the program that accesses it lives on the client machine.)

But my client (the human kind), like most PC users, is decidedly not interested in hiring C programmers. So to make a spreadsheet use the SQL-based server, I must make the spreadsheet a client process or somehow attach a client (the computer variety) process to the spreadsheet.

Furthermore, the client must be compatible with the server. Not every SQL client can talk to every SQL server. Given that SQL is billed as the lingua franca of the database world, this is surprising, but it's true. One of the leading SQL vendors, Gupta Technologies, counts among one of its greatest features the wide variety of SQL server products that it supports *besides* its own SQLBase server. (That's what its SQLNetwork gateways do.) In general, you're best off getting your spreadsheet client code from the same folks who wrote your SQL server code.



In general, you've got to worry about three things:

- What spreadsheet does the client talk to, and is it DOS- or OS/2-based?
- What SQL server does the client talk to?
- What network/communications link do the client and server share?

I'll now look at these in a bit more detail.

## Making Your Spreadsheet Speak SQL

There isn't, at least not yet, a "@SQL()" function in 1-2-3. So what's out there to solve the problems? There are three ways to do this: Use an add-in or patch, redesign the spreadsheet to support SQL directly, or use a language that the spreadsheet already understands and a translator program to handle SQL.

The most direct method is a patch or, in the case of 1-2-3, an add-in. Releases 2.x and 3.0 don't directly support SQL. But two products—Gupta Technologies' SQLVision and Oracle's SQL Add-In for 1-2-3—can extend 1-2-3 to accommodate SQL.

Gupta's SQLVision works straightforwardly. You just type SQL commands into a range in your spreadsheet, load your add-in, and go. Users of 1-2-3 will like the fact that it also offers a /Data Query–like mode. SQLBase also comes with an interactive front end called SQLTalk, which I have found quite nice for trying out SQL. So the bank's techies just stuff some SQL into the 1-2-3 macros that get distributed to the users, and

*continued*

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***Circle 160 on Reader Service Card***

# In Redondo Beach, California . . .

You'll find breathtaking ocean views, sensational surfers and Gateway 2000 computers.

Dive 'N Surf, famous for Body Glove® fashions and watersports equipment, is a member of the growing family of Gateway 2000 customers in California. Dive 'N Surf Computer Systems Manager Graham Pask chose a Gateway 25 MHZ 386 machine for his network server. The system runs point-of-sale, inventory control, word processing and desktop publishing software.

***Graham Pask, Computer Systems Manager for Dive 'N Surf, and his Gateway 2000 25 MHZ 386 network server.***

"I decided to buy a Gateway 2000 system because they had everything I wanted for a good price," said Graham. "But what really impressed me was the service. I had a problem with my 3 1/2 inch drive so they sent me a new drive the very next day."

Graham said he was so happy with his Gateway system at work that he bought a Gateway 2000 25 MHZ 386 Cache machine for his home.

*Until well after sunset, surfers ride the big waves on the Pacific Ocean near Redondo Beach, California.*

# In Bradford, Pennsylvania . . .

You'll find a charming small city nestled in the Allegheny National Forest. The city's most prominent local business is the Zippo Manufacturing Company, where you'll find 18 Gateway 2000 computers in use.

*Fred Gronemeyer, Zippo Manufacturing Company, and his Gateway 2000 20 MHZ 386 system.*

Zippo is known around the world for its windproof lighter made famous during the second World War, although today the company's product line includes many other specialty advertising items. Fred Gronemeyer, Systems Analyst for Zippo, chose Gateway 2000 as the company's standard PC.

"We needed to set standards for PC's and software to make the most efficient use of these tools," Fred remarked. "We started out with PC's from different manufacturers, but once I tried Gateway I was convinced we could get the highest quality, most reliable machines at the best price from Gateway 2000. I was also impressed by my salesman and the tech support people I've dealt with at Gateway."

Fred said by the end of the year Zippo will be running every system Gateway 2000 makes, from 286's up to a 486 and everything in between.

*Main Street, U.S.A., is located in Bradford, Pennsylvania.*

Larry Mahan raises registered Texas Longhorn cattle.

# Near Camp Verde, Texas . . .

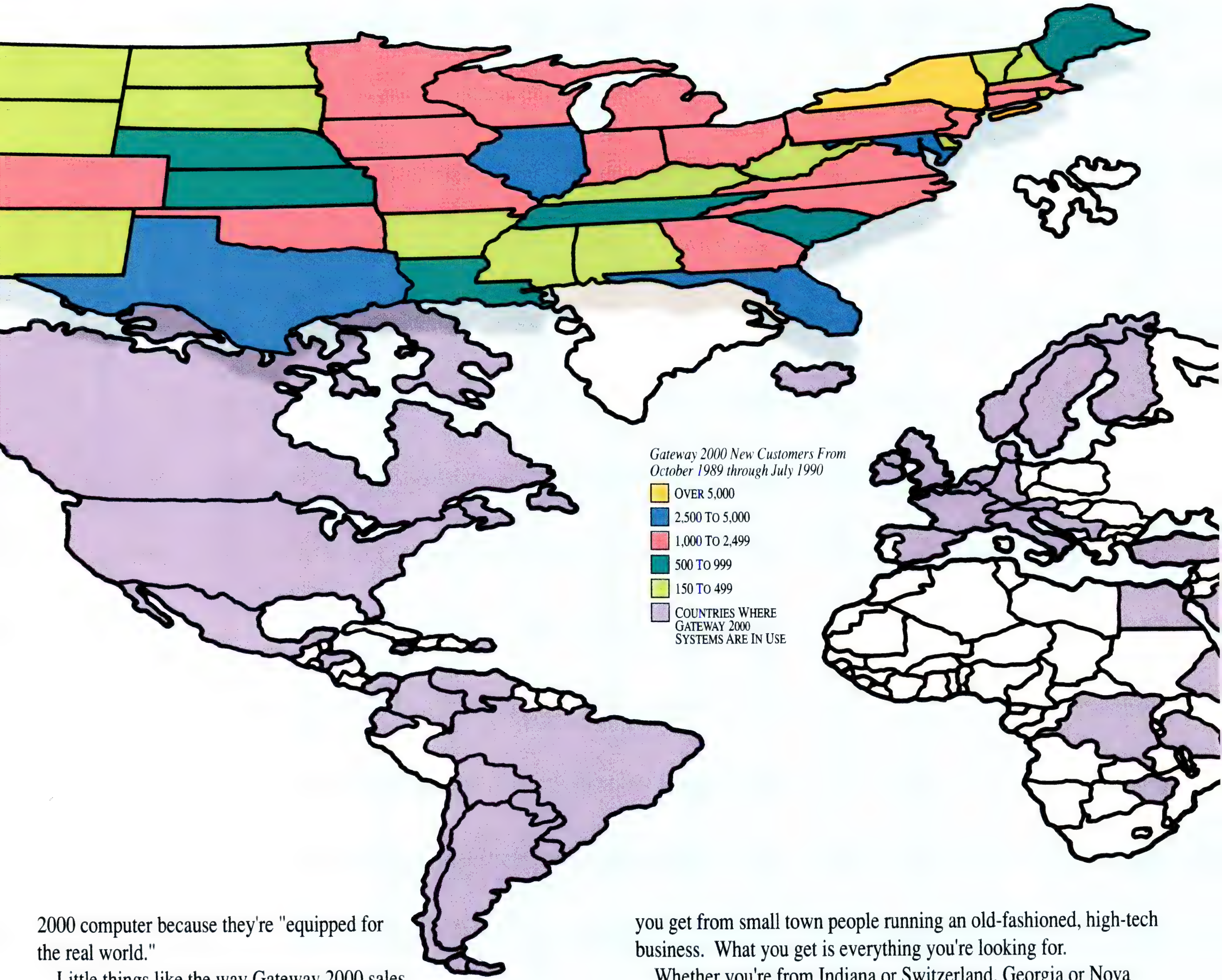
You'll find the magnificent Hill Country of Texas with rattlesnakes, prickly pear cactus and huge cattle ranches. You'll also find Larry Mahan and his Gateway 2000 computer.

*Larry Mahan, rodeo star, and his Gateway 2000 20 MHZ 386 system.*

Larry Mahan is to rodeo what Jack Nicklaus is to golf. He is Six Times World Champion All-Around Cowboy and is a member of the Cowboy Hall of Fame. But Larry also runs a cattle and horse ranch and is involved in a western apparel manufacturing company and a new Southwestern foods company. His Gateway 2000 20 MHZ 386 system is an integral part of his business operations. "We run cow and calf software for our Longhorn cattle herd," Larry said. "You can't really manage a livestock business efficiently without it. Plus we do accounting, spreadsheets and word processing on our Gateway 2000 computer."

Asked why he chose Gateway 2000, Larry said, "They had the best features and price – and I thought a computer company that puts pictures of cattle in their ads had to be my kind of people. And I was right. The people I've talked with at Gateway 2000 are honest-to-goodness nice folks. It's a pleasure doing business with them."

# AND AROUND THE WORLD, GATEWAY 2000!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2000 computer because they're "equipped for the real world."

Little things like the way Gateway 2000 sales people develop excellent business relationships with their customers. Fred Gronemeyer tried his first Gateway because he was impressed by his sales person. Eighteen systems later, Fred is still impressed by his sales person.

And the biggest little thing of all is the feeling you get when you deal with the people at Gateway 2000. As Larry Mahan said, "they're honest-to-goodness nice folks."

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# CROSSING OVER

*New software makes it easier to develop HyperCard-like applications on the PC*

I have done a fair amount of cross-platform development in my time, and it has never been very easy. I can recall trying to convert some complicated economic forecasting programs back in 1978. I brought these FORTRAN IV programs with me when I moved from Ohio State University to the University of Chicago. They were crucial for my historical research at the time, but I had written them using the FORTRAN IV compiler on an IBM 370 mainframe at OSU. Chicago's IBM mainframe ran a different version of FORTRAN, so I spent a couple of months converting my old source code to work on the new machine and then recompiling and linking. Not a fun process, I can tell you, even with a good debugger and line editor.

As much of a pain as that was, cross-platform development is more difficult. I need to develop instructional software that will run under the Mac OS, Windows 3.0, and the Unix X Window System, yet take full advantage of each system's inherent graphical user interface (GUI). So far, I haven't been able to find anything that successfully crosses all three operating-system boundaries nicely, but there is hope. Over the last couple of months, I have been working with a development system called Plus, which is published by Spinnaker Software. Plus runs on the Mac, OS/2 Presentation Manager (PM), and Windows 3.0 on the PC. Although the PC version should be shipping by the time you read this, this column is based on my work with beta software, which was done mostly without the benefit of printed Plus documentation for the IBM PC.

## A Plus for Porting

Plus lets you port existing HyperCard or Plus stacks from the Mac to IBM PCs and compatibles running OS/2 PM 1.2 or Windows 3.0. Plus is essentially a superset of HyperCard with improved object-oriented programming (OOP) features, a much better editor, and real development utilities.

Plus has been around for a while, first sold by Format Software of Germany, then Olduvai Software of Miami, and now Spinnaker. It seems that Plus has really found a home at Spinnaker, since it has been revised to include the OS/2 PM and Windows 3.0 versions. Before Spinnaker took it over, Plus was strictly a Mac product. While the Mac version is shipping, the PC version is still beta (although it's due out by the time you read this), so keep that caveat in mind.

Plus is Spinnaker's idea of what HyperCard could be with the programming interface extended and improved and with a wish list of extensible features (e.g., color support, resizable and scrollable windows, resource editing and implementation, additional object types, and improved data typing) added. But Plus is still not true OOP, so don't expect to find niceties like polymorphism, true inheritance, or a class browser. Plus also locks you into the same card metaphor as HyperCard, which may be unsuitable for your work. For mine, though, where I use HyperCard daily for instructional examples, Plus is just the ticket for simple cross-platform development and multiple system work.

The real beauty of Plus is that it's nearly identical on the Mac and PC. The only real differences are those nuances dictated by the underlying GUI. This means that Mac programmers should be able to port Plus stacks over to the PC without much PC experience, while PC programmers knowledgeable about PM or Windows will find their commute equally straightforward.

## According to the Script

Spinnaker built Plus's script editor into the system, as is the case with HyperCard's. In fact, Plus works much like

*continued*

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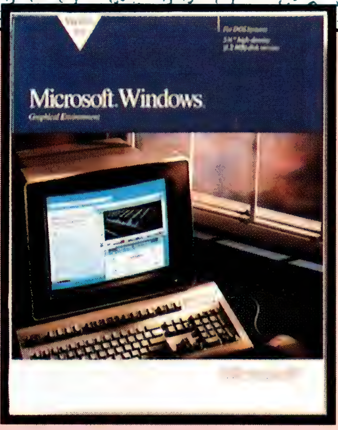

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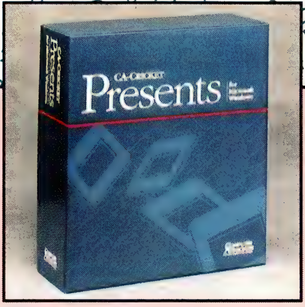

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*Microsoft's answer to multitasking hasn't lived up to its claims, but there are other choices*

# THROUGH A WINDOW, DARKLY

For years now, we've been told that OS/2's Presentation Manager (PM) is the answer to the business user's requirements for productivity. In a fit not to be outdone by Apple with its Macintosh interface, IBM and Microsoft created this super windowing software package that is supposed to let us use a mouse to switch between applications as easily as we change channels on our TVs. The problem is, there aren't enough applications to make switching necessary.

Then, earlier this year, we were told that the new version of Windows would do the same thing for the DOS world. All of a sudden, we would be able to engage in real multitasking—running communications software in one window while using a word processor in another. Once again, the answer to the business user's need for productivity was at hand with Microsoft's graphical user interface. Of course, the fact that Quarterdeck had been doing this for years with Desqview (albeit without the GUI) was ignored.

Now, business users find themselves with two choices, each of which the heavy hitters say is the right GUI. One, OS/2, is supported by the heaviest hitter of them all, IBM. The other, Windows 3.0, is supported by Microsoft, which also wrote OS/2. OS/2 treats all your computer's memory as a big contiguous space in which to run programs. Windows 3.0 lets you load several DOS programs, each into its own 640K-byte segment. OS/2 also lets you have a DOS segment, but you can have only one, and not everything runs in it.

## An Embarrassment of Riches?

Confronted with such choices, many business users might simply decide to ignore the whole thing and keep using plain old MS-DOS just as they always have. But can you afford to ignore either one of these? Can you afford to ignore both of them? Does either of Microsoft's GUIs have a place in your business?

To be useful in a business setting, a software package must do something to enhance the value of an employee. The employee must become more productive, more accurate, or more capable than before; otherwise, the software is just a waste of money. In addition, the software must not require resources that outstrip the value to be gained. If you have to spend $10,000 on computer hardware and software to realize a productivity gain of $5000 over the economic life of the computer, you have just thrown away the money you invested.

Accordingly, Windows and PM must do something worthwhile if they are to play a role in business, and, in addition, users should be able to justify them economically. I looked at Windows 3.0 and PM in a variety of environments to see if either of them makes sense. While I was at it, I checked out Desqview 386.

To make sure that I looked at machines similar to what most businesses use, I tried Windows 3.0 and PM on an old 8-MHz, 286-based Zenith Z-248. I also sized up more modern equipment—a Zenith 386/33, a Cheetah 386/25, and a Gateway 2000 386/25. I did not test Windows 3.0 on an 8088-based machine, even though it will allegedly run on one, because of reports that the operation is so slow as to be ludicrous.

PM and Windows 3.0 seem to be very similar at first glance. (For more information on the user interfaces, see "PC GUIs Go Head to Head" on page 82.) There are some significant differences in the software, however, and they can have a major effect on whether or not the packages will be useful to you and your business.

## Is OS/2 the Answer?

OS/2's most important difference is that it's not MS-DOS. This statement may sound silly, but remember that most of

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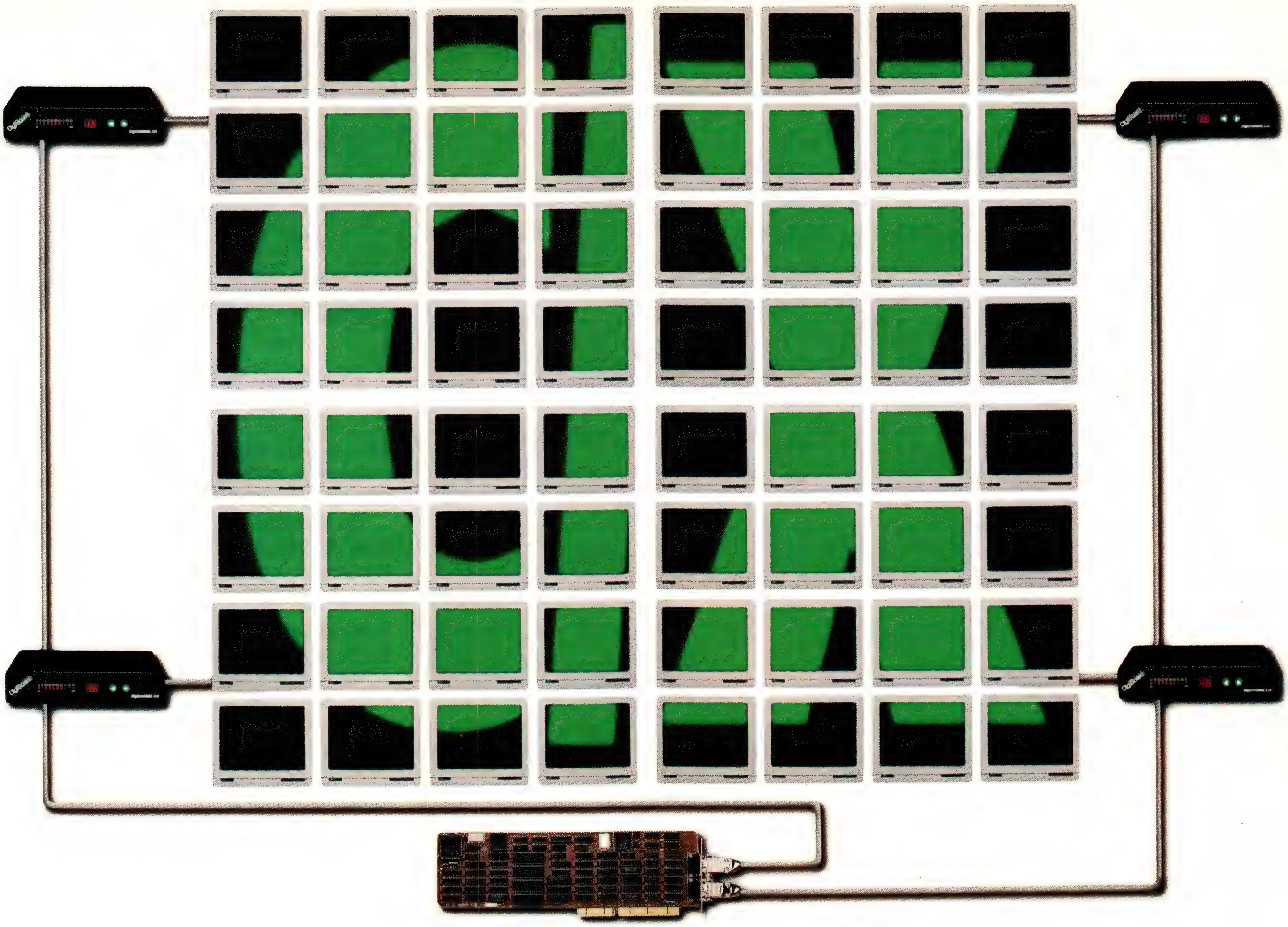

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THE UNIX /bin ■ David Fiedler

*New Unix-specific machines from IBM indicate a new attitude toward Unix*

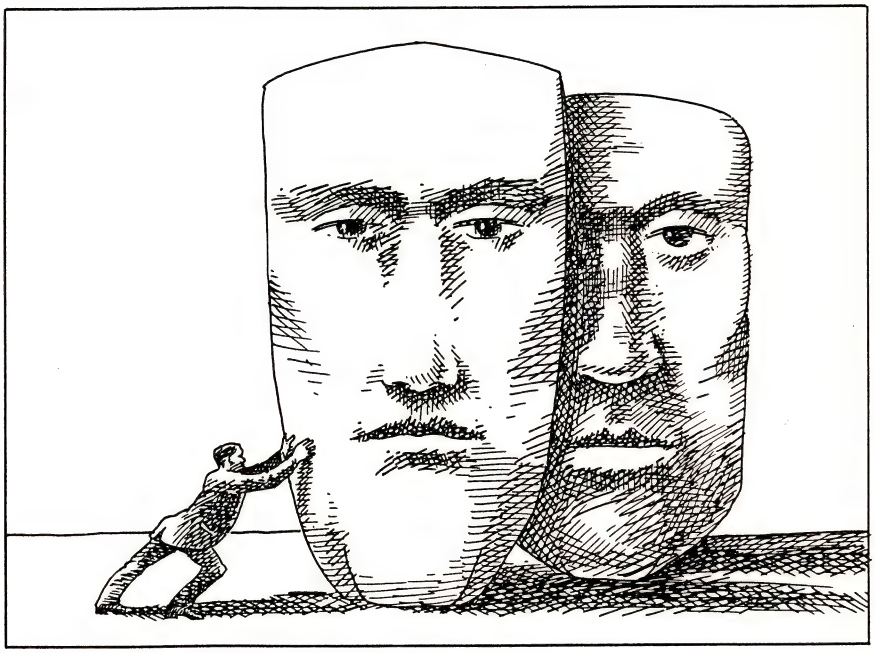
# IBM AND UNIX: PERFECT TOGETHER?

Everyone knows that AT&T wrote Unix. But that hasn't stopped IBM from developing products that have changed the face of the Unix industry and will continue to do so for some time. You could even say that IBM has been responsible for several of the more important de facto standards in Unix—and until recently, the products that have set these standards weren't even Unix products!

Look at the venerable IBM AT. Based on the Intel 286 CPU, the AT started to create interest in a modest way when firms such as Microport and The Santa Cruz Operation (SCO) ported Unix and Xenix for it. When multiport serial boards appeared on the market, the AT thus became a moderately priced, standardized base for multiuser applications.

In many ways, this was the true beginning of the low-end Unix market. Before the AT, low-priced Unix machines had been mostly 68000-based computers, with widely differing and incompatible architectures. The AT was a known entity with well-defined characteristics, and it had gotten into many developers' hands. So it was logical that it was a popular destination for DOS developers wishing to port their programs to Xenix and Unix: They already had the hardware, and so did their customers.

This is also how Xenix became so popular, since it was one of the first "serious" versions of Unix intended for small computers that had some of the extensions needed for business. SCO aggressively marketed Xenix to developers through direct sales and channels such as Tandy, which made its own series of Xenix-compatible computers (some of which were also based on Intel CPUs).



### Chips Ahoy

The introduction of the Intel 386 CPU probably did more for this segment of the Unix market than any move AT&T ever made. The 386 was an instant success, but not quite the way IBM had planned. While IBM's sole 386 machine belonged to its new line of Micro Channel architecture machines, everyone else started dropping 386 chips into reworked AT motherboards. Suddenly, the most-wanted personal computer in the IBM world was something that IBM didn't make (and still doesn't): a 386-based version of the AT.

In addition, although many DOS-based PC users looked at their 386 machines as an expensive status symbol (which was true in some cases where people weren't doing serious graphics and CAD work), Unix users knew just what to do with all that power. It was desperately needed for the multiuser applications that had been stretching the 286-based AT computers to their limit. 386 PCs running Unix could now become a major force in the market.

There were technical, not just market-driven, reasons for this. The 386 is a much more powerful processor, is faster internally than the 286 while being upwardly compatible with it, and can run at clock speeds of up to 33 MHz. It has a fully separate supervisor mode, so a 386 Unix kernel can be run completely protected from the vagaries of user programs. Perhaps most important, the "virtual 8086" mode of the 386 CPU enabled software companies such as Locus Computing and Interactive Systems (together with Phoenix Technologies) to write emulators for MS-DOS that allow an entire DOS system to be run as a task under 386 Unix. This support of an IBM standard allowed more DOS users to see the potentials of Unix.

For the first time, Unix users could have a powerful processor at a reasonable price, on a totally standard hardware platform that was compatible with MS-DOS. Add to this the standard Unix ports available from AT&T, Interactive Systems, Intel, SCO, and others, and it's

*continued*

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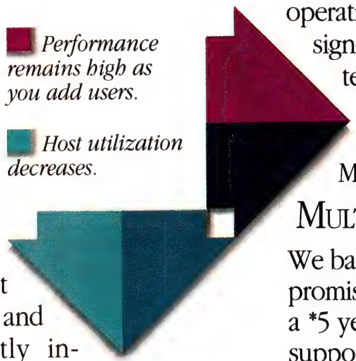

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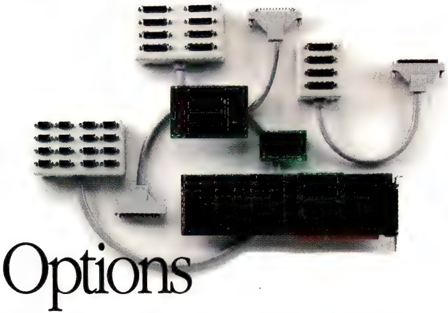

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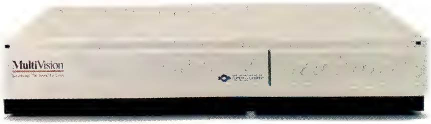

## Graphics

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|---|---|---|
| YES | IEEE-488 GPIB (HP-IB), RS-232 Instrument Control | YES |
| YES | Integrated Environment: Mouse, Editor, Debugger, Calculator | YES |
| YES | Supports 16 Megabytes of Memory (breaks DOS 640K barrier) | YES |
| YES | Engineering Math: Matrix Math, Complex Numbers | YES |
| YES | High Level Graphics: Screen, Plotter, Printer | YES |
| YES | Structured Programming with Independent Subprograms | YES |
| YES | Runs on Industry Standard Personal Computers | NO* |
| YES | Industry Standard Graphic Printer Support: Epson, IBM, lasers, etc. | NO |
| YES | Industry Standard Network Support: Novell, IBM, Microsoft, NFS, etc. | NO |
| YES | Industry Standard IEEE-488 Support: National Instruments, IOtech, etc. | NO |
| YES | Exchange data files with Industry Standard PC applications | NO* |
| YES | No-charge Telephone Technical Support | NO |
| YES | Instant on-line HELP system | NO |

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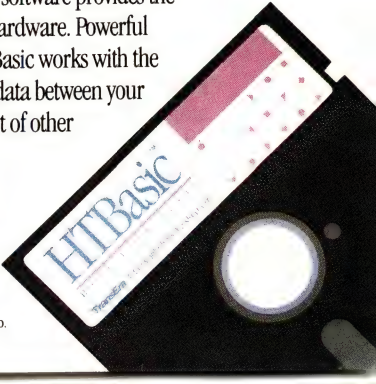
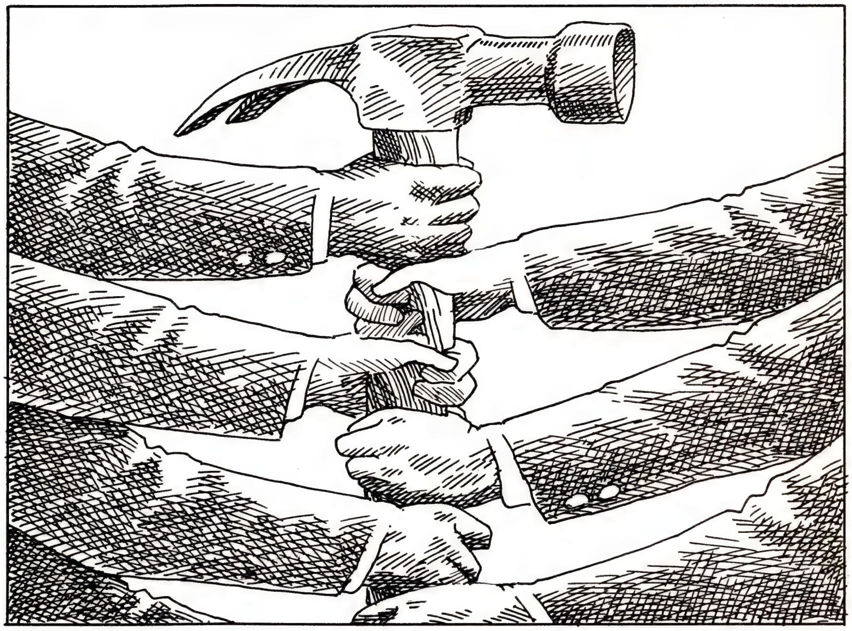


NETWORKS ■ Mark L. Van Name and Bill Catchings

*Can Netware and LAN Manager learn to get along?*

# NETWORK PERESTROIKA



Any carpenter can tell you which tool is the right one for a given task. The same thing is true of LAN administrators selecting a LAN operating system; in both cases, you choose the one that best meets your requirements.

But it's not that simple. That strategy works when you choose your first LAN operating system, but what about the next time? Do you go with the LAN operating system you bought earlier, or do you choose the one that's right for your second job? They aren't always the same.

If you stick with a single LAN operating system, making your LANs work together is fairly simple; most vendors do a decent job of ensuring that their own products integrate reasonably. Choose two different LAN operating systems, however, and it's a whole different story.

We're faced with that situation in our lab, where NetWare and LAN Manager servers sit on the same Ethernet wire. And we are not alone. LAN Manager (as offered by such vendors as IBM, 3Com, and Microsoft) and NetWare are the two biggest PC LAN operating systems. More and more large organizations are in the awkward position of trying to let their network users work with both NetWare and LAN Manager servers.

## What You Want

What's so frustrating about that situation is that the ideal answer is obvious: You want all your client PCs to be able to work with both types of servers simultaneously. Each client PC should be able to take advantage of the file, printing, and other services of both the LAN Manager and NetWare servers. Even more frustrating is that this solution is technically possible—but not likely. To see both how this solution could work and why it's not likely to happen, let's look closer at a single server function: file services.

NetWare and LAN Manager client PCs have the same three basic types of file-service software: a device driver, a protocol stack, and a redirector. The device driver lets the higher-level software talk to the network adapter card, such as the Ethernet cards we use in our lab. The redirector intercepts server file requests and makes them happen. Between the device driver and the redirector sits a protocol stack that sets up and manages communication sessions with the server.

Thus, to let a single client PC use both NetWare and LAN Manager servers, we need one device driver, one protocol stack, and two redirectors—one for the NetWare requests and one for the LAN Manager requests. Put another way, all we need is for Microsoft and Novell to agree to use the same device drivers and protocol stack, and we're in business.

Not a chance. At least, not yet. Both vendors have their own device driver standards and their own protocol stacks. Both are even working on their own standards for those parts. Novell's Open Link Interface defines a standard interface between device drivers and the protocol stack. The Microsoft/3Com LAN Manager equivalent is the Network Driver Interface Specification.

Unfortunately, the two standards are different. Worse, they're likely to remain that way. It's like the old joke: How many psychiatrists does it take to change a light bulb? Only one, but first the bulb must want to change. Microsoft and Novell don't want to use the same protocol stacks, so they won't.

## What You Need

Because Microsoft and Novell won't change, we can't get the ideal solution that we want. We might, however, be able to get what we need.

For example, if we can't have a single standard software set, how about a way to run two sets at once? All we need is two device drivers, two protocol stacks, and two redirectors—and the redirectors

*continued*

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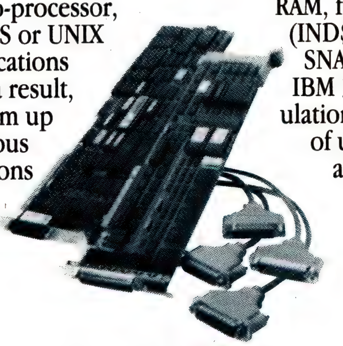

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# IBM IN THE NINETIES

*A look at what lies ahead for Big Blue in the coming decade*

*Nick Baran*

Nowadays, when you hear talk of IBM, it's no longer just the company that's being referred to, but an entire industry. Personal computer owners who say they have an "IBM" may very well be referring to a PC clone from Korea or Taiwan. Virtually every new technology in the microcomputer industry finds its way into IBM-compatible machines.

## The Personal Computer Coup

As IBM enters the 1990s, the company faces a drastically different set of challenges than it faced a decade ago. When IBM introduced the PC in 1981, the personal computer was sort of a special project for IBM—an experiment. In spite of its unexpectedly enormous success, the PC in those early years accounted for only about 5 percent of IBM's gross revenues. Today, "the personal systems business," as IBM's James Cannavino calls it, accounts for about 16 percent of IBM's revenues, about 10 billion dollars' worth in 1989, according to figures given by Cannavino at a speech in New York last April.

Nevertheless, IBM enjoyed a much more comfortable situation in the early 1980s. Its main business consisted of mainframes and minicomputers, which yielded large profit margins and guaranteed additional future income in the form of maintenance contracts and leased software. Little did IBM know that its PC experiment would unleash a revolution in computing that would forever change IBM's standing in the marketplace—from a position of dominance to that of having to keep up with relentless competition and technical innovation.

IBM's dependence on its personal systems business will undoubtedly continue to grow as desktop computers based on Intel's 386 and i486 processors replace older minicomputer systems like the IBM System/38 as database and file servers for networks of personal computers. In addition, IBM has aggressively entered the Unix workstation market with its RISC-based System/6000 line of machines, which must also be classified as personal systems. Note that IBM now refers to "personal systems" rather than "personal computers," emphasizing the concept of a complete office system rather than a stand-alone computer for individual users.

In fact, personal computing on an individual basis is no longer the driving force behind the personal computer industry. The driving forces now are workgroups and organizations that share information and resources on a network. Initially, the personal computer was popular because it let you work independently on your own computer, away from the controls of system administrators, endless print queues, and the unpredictable performance fluctuations of mainframe or minicomputer systems. Now, the trend is back to organizational computing. But instead of centralized minicomputer and mainframe hosts, we now have distributed computing; each node on the network has its own processor, as well as access to the other processors and peripherals on the network.

Another trend has been toward computers with graphical user interfaces, which require graphics-based displays rather than character-based or alphanumeric displays. GUIs, along with the organizational computing model, have forced personal computer designers to make changes in the basic design of small computers.

## New Hardware for Networks and Graphics

The trends toward GUIs and "workgroup" computing have led PC designers to adapt the basic model of a single processor—with a single, buffered I/O bus—to the more demanding requirements of multitasking, networking, and high-speed graphics. Recently, several vendors, including IBM, Hewlett-Packard, and Compaq, have introduced powerful extensions to the basic IBM PC architecture to provide the additional horsepower required by the networked and graphical environment.

For example, IBM introduced a new version of its Micro Channel architecture that supports data transfer rates of up to 40 megabytes per second, about twice as fast as the maximum performance of the original Micro Channel architecture bus. Compaq included dual-processor capability in its Systempro to

*continued*

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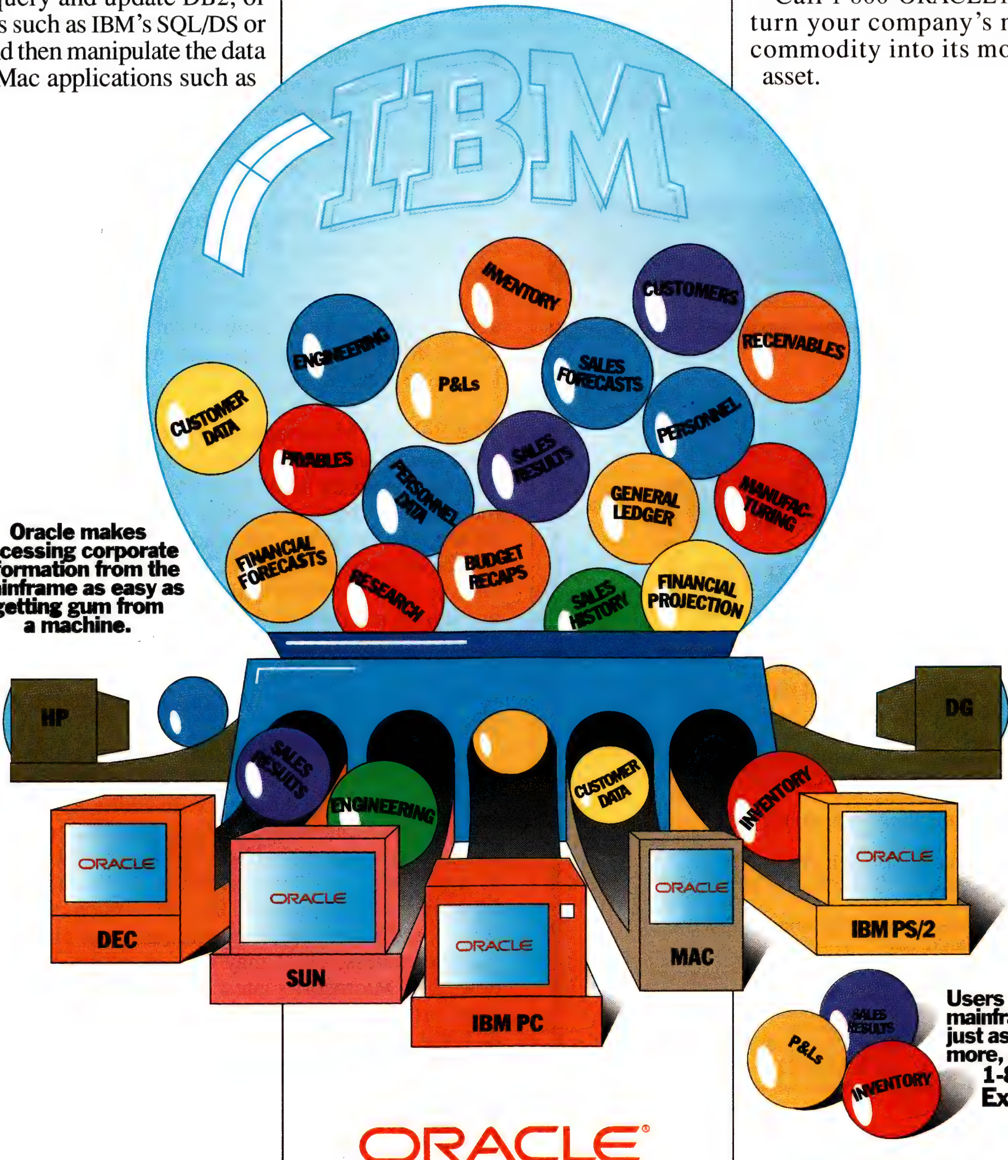

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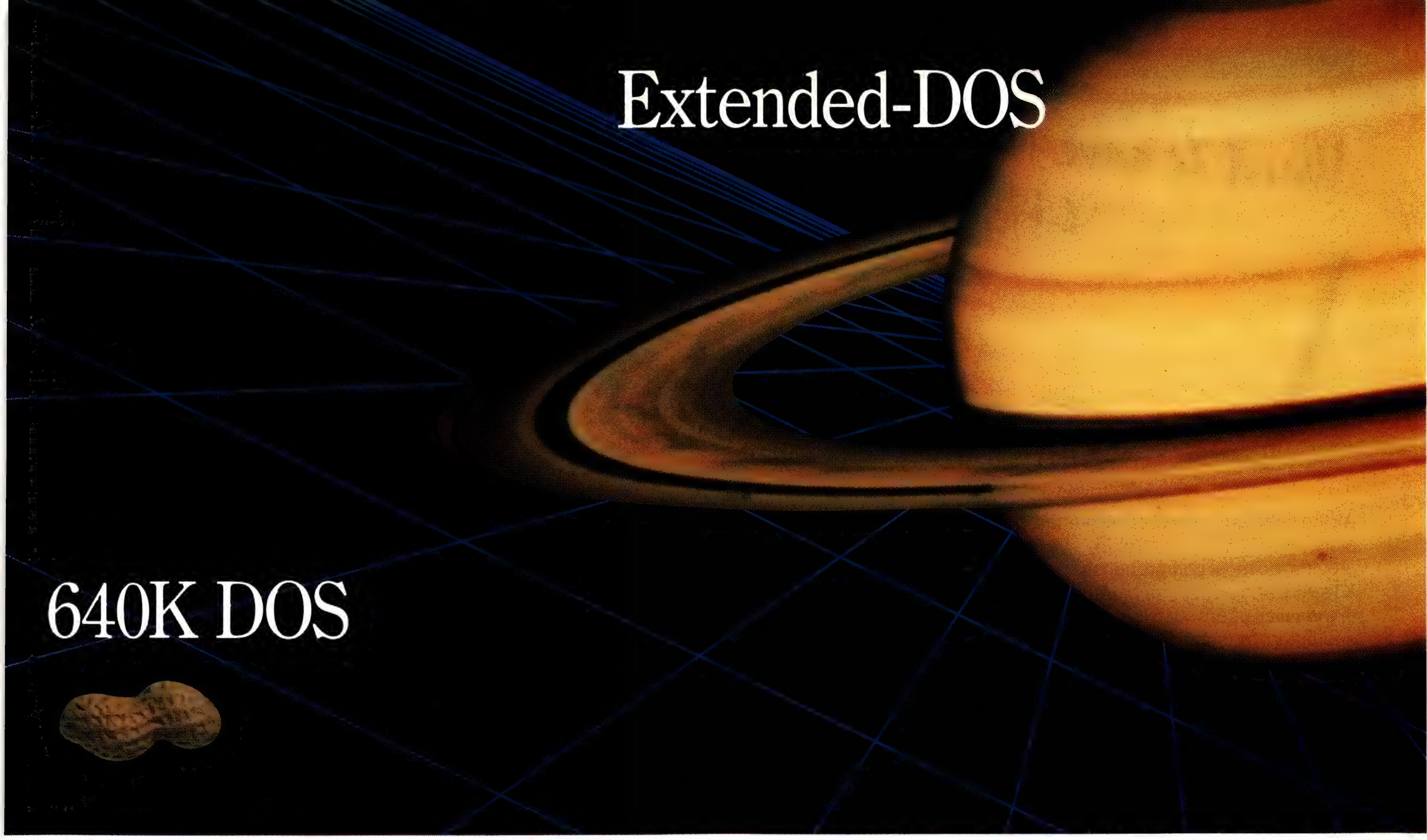

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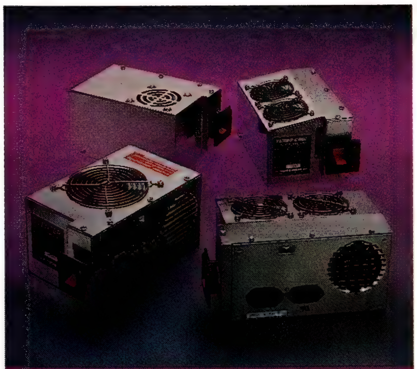

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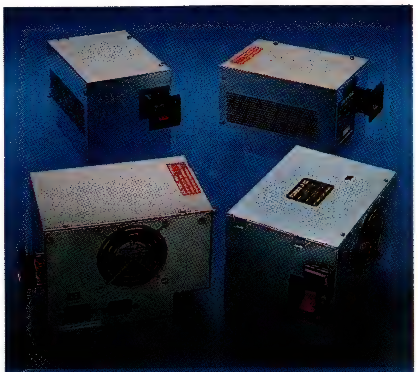

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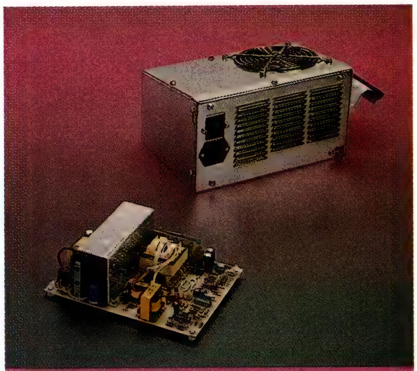

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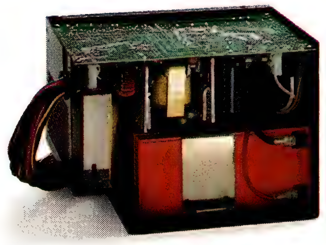

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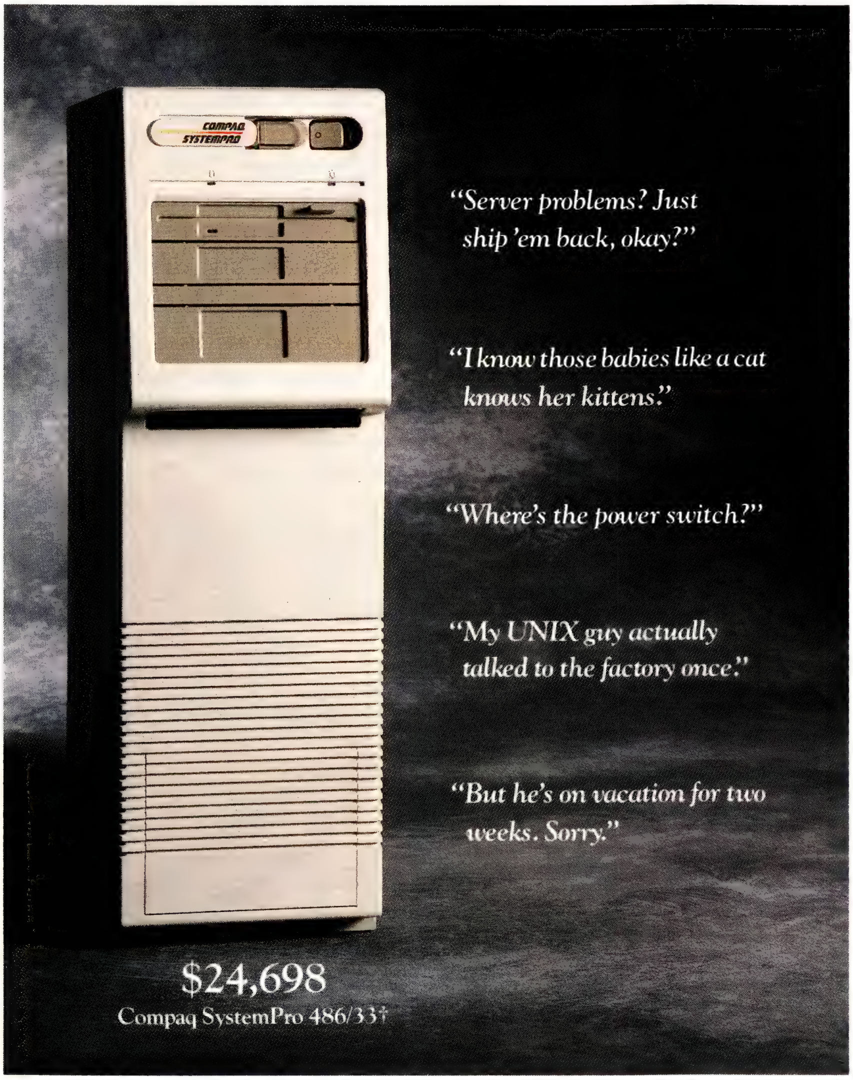
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# BENCHMARKS AT A GLANCE: 1990

## *BYTE's performance rankings of popular IBM PC compatibles, Unix systems, and Macs*

*Compiled by Stanford Diehl*

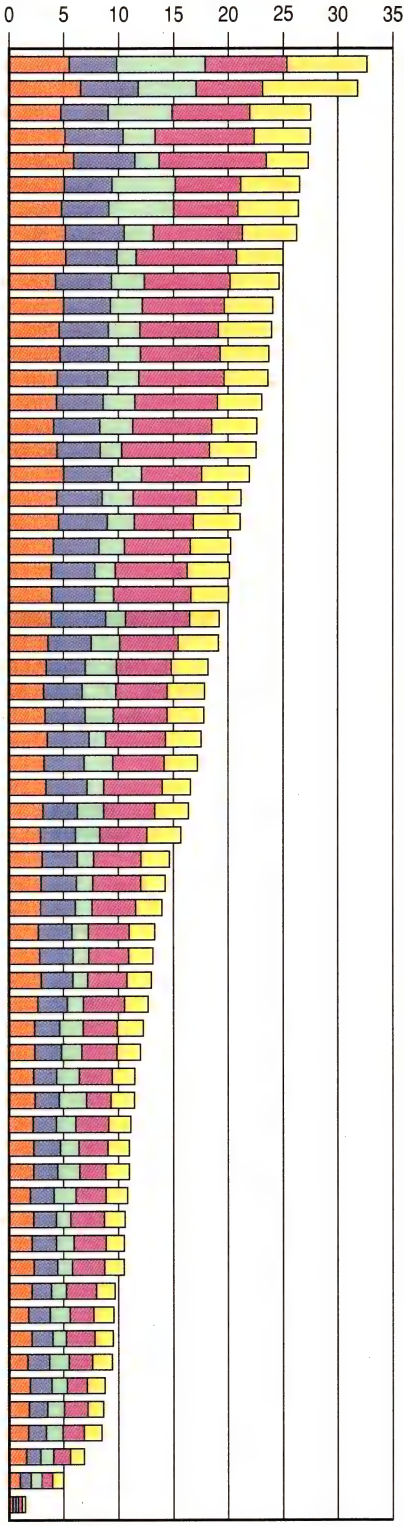
We've just about run out of adjectives to describe the steady supply of new machines arriving at the BYTE Lab for benchmarking: smoking, screaming, blazing, barn-burning. . . . Each time we think "they can't get much faster than *this*," a new system proves us wrong. Speeds for 386-based systems steadily rose from 20 to 25 to 33 MHz, and then when the processor speed topped out, we started receiving high-performance file servers stocked with megabytes of hard disk caching. Now the i486 has arrived, setting a new performance standard. Intel's latest processor, already available in 25- and 33-MHz flavors, will soon reach 50 MHz and beyond. One day soon, we expect a sonic boom to blast from one of these boxes.

*continued*

Compaq Systempro

## BYTE DOS BENCHMARK INDEXES (VERSION 1.0) WITH MATH COPROCESSOR

| Computer | WP | SS | DB | Sci./Eng. | Cmplr. | |
|---|---|---|---|---|---|---|
| | **Applications** | | | | | |
| SIA 386/33[1] | 5.49 | 4.32 | 8.09 | 7.42 | 7.32 | 32.64 |
| Mylex 486/EISA[2,3] | 6.53 | 5.25 | 5.30 | 6.04 | 8.68 | 31.80 |
| Micro Express ME 386/33[1] | 4.76 | 4.32 | 5.83 | 7.12 | 5.55 | 27.58 |
| Dyna Micro AIR486-C | 5.14 | 5.30 | 2.92 | 9.07 | 5.11 | 27.54 |
| AST Premium 486/25 | 5.93 | 5.58 | 2.21 | 9.81 | 3.83 | 27.36 |
| National Micro Systems Flash 386/33[1] | 5.08 | 4.35 | 5.77 | 6.00 | 5.37 | 26.58 |
| FiveStar Model 33/D (386/33)[1] | 4.82 | 4.31 | 5.91 | 5.90 | 5.53 | 26.47 |
| Dolch-P.A.C. 486-25 | 5.18 | 5.35 | 2.68 | 8.15 | 4.94 | 26.31 |
| Spear Super 486/25U | 5.22 | 4.67 | 1.75 | 9.18 | 4.25 | 25.06 |
| Compaq Deskpro 386/33 | 4.28 | 5.01 | 3.00 | 7.86 | 4.46 | 24.61 |
| Dyna Cache 386/33 | 5.02 | 4.27 | 2.91 | 7.51 | 4.42 | 24.13 |
| ALR FlexCache 33/386 | 4.61 | 4.50 | 2.88 | 7.18 | 4.86 | 24.02 |
| Blackship 386/33 | 4.69 | 4.45 | 2.89 | 7.30 | 4.44 | 23.77 |
| Compaq Systempro | 4.45 | 4.59 | 2.85 | 7.80 | 4.00 | 23.69 |
| Fortron NetSet 333 (386/33) | 4.37 | 4.27 | 2.88 | 7.57 | 4.04 | 23.13 |
| AST Premium 386/33 | 4.11 | 4.22 | 3.01 | 7.23 | 4.11 | 22.69 |
| Everex Step 386/33 | 4.43 | 3.93 | 1.96 | 8.05 | 4.25 | 22.62 |
| PC Link 386/33 | 5.03 | 4.43 | 2.68 | 5.51 | 4.36 | 22.01 |
| ALR FlexCache 25386 | 4.41 | 4.13 | 2.83 | 5.80 | 4.08 | 21.24 |
| Tangent 333 (38633) | 4.57 | 4.45 | 2.45 | 5.43 | 4.27 | 21.17 |
| Acer 1100/33 | 4.10 | 4.16 | 2.33 | 6.03 | 3.69 | 20.32 |
| Zenith Z-386/33 | 3.91 | 3.97 | 1.87 | 6.59 | 3.85 | 20.19 |
| Matrix MDP 386/33 | 3.95 | 3.90 | 1.74 | 7.09 | 3.43 | 20.11 |
| ALR PowerFlex i486 | 3.90 | 4.97 | 1.81 | 5.89 | 2.69 | 19.26 |
| AST Premium 386/25[2] | 3.62 | 3.93 | 2.60 | 5.36 | 3.68 | 19.20 |
| Dell System 310 (386/20) | 3.45 | 3.56 | 2.84 | 4.98 | 3.41 | 18.24 |
| Compaq Deskpro 38620 | 3.20 | 3.51 | 3.09 | 4.67 | 3.45 | 17.93 |
| Toshiba T5200/100 (386/20) | 3.34 | 3.66 | 2.57 | 4.89 | 3.40 | 17.86 |
| ALR MicroFlex 7000 (386/25) | 3.54 | 3.82 | 1.50 | 5.45 | 3.30 | 17.61 |
| Compaq 386/20e[2] | 3.26 | 3.64 | 2.62 | 4.68 | 3.07 | 17.26 |
| IBM PS/2 Model 70-A21 (386/25) | 3.42 | 3.75 | 1.52 | 5.33 | 2.62 | 16.64 |
| Dolch-P.A.C. 386-25 | 3.16 | 3.14 | 2.37 | 4.67 | 3.11 | 16.45 |
| Micro Express Regal II (386/20) | 2.93 | 3.18 | 2.22 | 4.29 | 3.14 | 15.76 |
| FiveStar Model 320 (386/20) | 3.07 | 3.21 | 1.49 | 4.31 | 2.59 | 14.67 |
| Tandy 5000 MC (386/20) | 2.97 | 3.23 | 1.50 | 4.35 | 2.23 | 14.27 |
| Tandon 386 (386/20) | 2.91 | 3.19 | 1.52 | 3.97 | 2.41 | 14.01 |
| Compaq Portable 386 (386/20) | 2.68 | 3.11 | 1.49 | 3.73 | 2.32 | 13.33 |
| IBM PS/2 Model 80-111 (386/20)[2] | 2.81 | 3.07 | 1.45 | 3.63 | 2.21 | 13.16 |
| IBM PS/2 Model P70 386 (386/20) | 2.99 | 2.88 | 1.35 | 3.58 | 2.22 | 13.02 |
| IBM PS/2 Model 70-121 (386/20) | 2.63 | 2.74 | 1.46 | 3.75 | 2.15 | 12.72 |
| NEC ProSpeed 386 (386/16) | 2.34 | 2.33 | 2.14 | 3.11 | 2.37 | 12.29 |
| AST Premium 386SX | 2.36 | 2.47 | 1.85 | 3.21 | 2.14 | 12.03 |
| Compaq 386s (386SX/16) | 2.24 | 2.15 | 2.06 | 3.01 | 2.05 | 11.51 |
| ADC Powerlite 386 SX | 2.38 | 2.25 | 2.48 | 2.24 | 2.13 | 11.47 |
| PC Brand 386/SX-16 | 2.21 | 2.17 | 1.77 | 3.00 | 2.01 | 11.16 |
| Toshiba T5100 (386/16) | 2.25 | 2.48 | 1.69 | 2.64 | 1.97 | 11.04 |
| Swan 386SX (386SX/16) | 2.25 | 2.23 | 2.01 | 2.38 | 2.14 | 11.02 |
| Zenith TurbosPort 386 (386/12) | 1.93 | 2.22 | 2.00 | 2.73 | 1.97 | 10.84 |
| Gateway 386SX | 2.24 | 2.11 | 1.32 | 3.06 | 1.89 | 10.62 |
| ALR PowerFlex 386SX | 2.09 | 2.27 | 1.60 | 2.93 | 1.65 | 10.55 |
| IBM PS/2 Model 70-E61 (386/16) | 2.28 | 2.18 | 1.35 | 2.94 | 1.78 | 10.52 |
| Mitac 2386 (386/16) | 2.08 | 1.82 | 1.36 | 2.76 | 1.67 | 9.70 |
| GridCase 1530 (386/12.5) | 1.78 | 2.01 | 1.81 | 2.17 | 1.82 | 9.58 |
| IBM PS/2 Model 55 SX | 2.07 | 1.97 | 1.21 | 2.61 | 1.67 | 9.53 |
| GridCase 1535 EXP (386/12.5) | 1.69 | 2.04 | 1.78 | 2.13 | 1.80 | 9.44 |
| Wedge Turbo 286 (286/24) | 1.92 | 2.02 | 1.40 | 1.82 | 1.62 | 8.78 |
| ALR PowerFlex 286 | 1.83 | 1.73 | 1.52 | 2.14 | 1.43 | 8.65 |
| Compaq LTE/286 | 1.77 | 1.66 | 1.52 | 1.93 | 1.61 | 8.50 |
| AST Bravo/286 (286/8) | 1.57 | 1.30 | 1.22 | 1.53 | 1.27 | 6.89 |
| IBM PC AT (286/8)[2] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 5.00 |
| IBM PC XT (8086/4.7)[2] | 0.33 | 0.28 | 0.22 | 0.35 | 0.29 | 1.47 |



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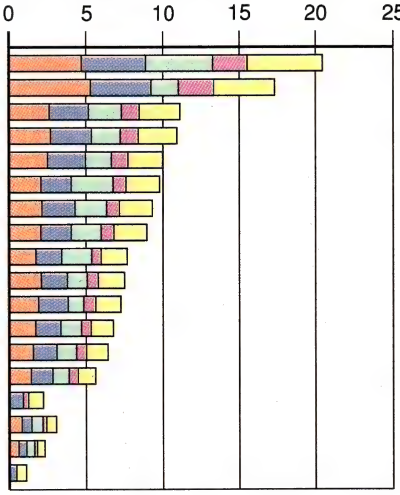
[1] Optional hardware disk cache installed.
[2] Systems listed for reference only.
[3] Not a commercial system; technology demonstration unit.

## BYTE BENCHMARK INDEXES (VERSION 1.0) WITHOUT MATH COPROCESSOR

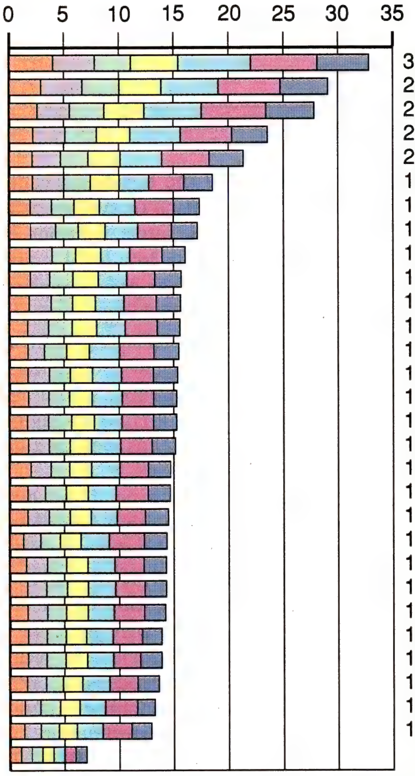
| Computer | WP | SS | DB | Sci./Eng. | Cmplr. | |
|---|---|---|---|---|---|---|
| Zenith Z-386/33E | 4.73 | 4.17 | 4.38 | 2.23 | 4.91 | 20.42 |
| Everex/SDI FileMaster II | 5.32 | 3.93 | 1.80 | 2.28 | 3.96 | 17.29 |
| Acma 386/20[1] | 2.64 | 2.55 | 2.14 | 1.15 | 2.67 | 11.14 |
| Northgate 386/20[1] | 2.73 | 2.65 | 1.87 | 1.16 | 2.54 | 10.95 |
| Bitwise 386/20[1] | 2.53 | 2.46 | 1.68 | 1.08 | 2.24 | 9.99 |
| Tandon LT/386 | 2.10 | 1.96 | 2.72 | 0.84 | 2.17 | 9.79 |
| Zenith SupersPort SX | 2.17 | 2.14 | 2.05 | 0.83 | 2.13 | 9.32 |
| Dell 316LT | 2.09 | 1.97 | 1.94 | 0.83 | 2.13 | 8.95 |
| Compaq SLT/286 (286/12) | 1.77 | 1.67 | 1.95 | 0.61 | 1.69 | 7.70 |
| NCR 386SX (386SX/16)[1] | 2.11 | 1.70 | 1.28 | 0.72 | 1.71 | 7.52 |
| Toshiba T3100SX | 1.94 | 1.91 | 1.02 | 0.78 | 1.62 | 7.28 |
| Ogivar 286 Laptop (286/12.5) | 1.75 | 1.63 | 1.34 | 0.62 | 1.45 | 6.79 |
| Zenith SupersPort 286 (286/12) | 1.59 | 1.53 | 1.28 | 0.64 | 1.40 | 6.43 |
| Mitsubishi MP-286L (286/12) | 1.45 | 1.41 | 1.05 | 0.59 | 1.13 | 5.64 |
| NEC UltraLite (V30/9.83) | N/A | 0.90 | N/A | 0.35 | 0.99 | N/A |
| Sharp PC-4641 | 0.82 | 0.67 | 0.72 | 0.24 | 0.64 | 3.10 |
| GridCase 140 XT | 0.61 | 0.51 | 0.55 | 0.18 | 0.49 | 2.34 |
| Zenith MinisPort | N/A | 0.47 | N/A | N/A | 0.63 | N/A |



[1] Systems listed for reference only.
N/A=Not applicable.

## BYTE BENCHMARK INDEXES (VERSION 2.0) WITH MATH COPROCESSOR

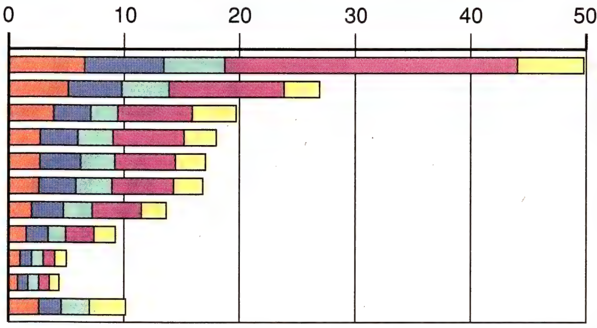
| Computer | WP | DTP | DB | Cmplr. | CAD | Sci./Eng. | SS | |
|---|---|---|---|---|---|---|---|---|
| Club 386/33[1] | 4.02 | 3.79 | 3.29 | 4.34 | 6.61 | 6.07 | 4.70 | 32.82 |
| Dell System 325[1] | 2.92 | 3.76 | 3.37 | 3.81 | 5.23 | 5.63 | 4.37 | 29.09 |
| Compaq Deskpro 386/25e | 2.60 | 2.94 | 3.14 | 3.63 | 5.26 | 5.84 | 4.44 | 27.85 |
| Compaq 386/20[1] | 2.20 | 2.92 | 2.87 | 3.03 | 4.63 | 4.67 | 3.24 | 23.56 |
| Compaq 386/20 SX[1] | 2.14 | 2.57 | 2.59 | 2.92 | 3.78 | 4.35 | 3.10 | 21.45 |
| Micro Express ME 386SX | 2.17 | 2.84 | 2.41 | 2.61 | 2.71 | 3.20 | 2.61 | 18.55 |
| Dell System 320LX | 1.90 | 1.99 | 2.05 | 2.30 | 3.23 | 3.53 | 2.36 | 17.35 |
| Everex Step 386is | 1.95 | 2.31 | 2.06 | 2.44 | 2.96 | 3.10 | 2.35 | 17.16 |
| AT&T 6386/SX | 1.85 | 2.08 | 2.15 | 2.28 | 2.63 | 2.92 | 2.15 | 16.05 |
| Zeos 386/SX | 1.90 | 1.81 | 2.11 | 2.31 | 2.58 | 2.53 | 2.45 | 15.69 |
| Tatung TCS-8800 | 1.79 | 2.05 | 1.95 | 2.06 | 2.60 | 2.94 | 2.24 | 15.63 |
| Hewlett-Packard Vectra QS/16S | 1.65 | 1.95 | 2.15 | 2.21 | 2.61 | 2.89 | 2.12 | 15.58 |
| Acer 1100/SX | 1.68 | 1.54 | 2.02 | 2.06 | 2.74 | 3.12 | 2.31 | 15.47 |
| Epson Equity 386SX | 1.67 | 2.00 | 1.89 | 2.02 | 2.64 | 2.89 | 2.24 | 15.34 |
| Club American 316/SX | 1.72 | 1.89 | 1.88 | 2.05 | 2.73 | 2.86 | 2.14 | 15.29 |
| NEC PowerMate SX Plus | 1.61 | 1.98 | 2.09 | 2.06 | 2.51 | 2.87 | 2.15 | 15.28 |
| CPI Goupil Golf | 1.70 | 1.94 | 1.90 | 1.93 | 2.66 | 2.85 | 2.16 | 15.14 |
| Acma 386 SX | 1.93 | 1.87 | 1.69 | 1.99 | 2.58 | 2.57 | 2.05 | 14.67 |
| Arche Rival SX | 1.64 | 1.64 | 1.90 | 1.98 | 2.54 | 2.91 | 2.05 | 14.67 |
| CSR 386/SX-16 | 1.63 | 1.99 | 1.91 | 1.91 | 2.36 | 2.54 | 2.11 | 14.45 |
| DTK Peer\1660 | 1.24 | 1.61 | 1.78 | 1.87 | 2.57 | 3.18 | 2.06 | 14.31 |
| Samsung SD700 | 1.49 | 1.96 | 1.74 | 1.94 | 2.45 | 2.64 | 2.03 | 14.25 |
| Tandy 4016SX | 1.59 | 1.79 | 1.89 | 1.89 | 2.48 | 2.67 | 1.95 | 14.25 |
| Wang PC350/16S | 1.62 | 1.84 | 1.71 | 1.97 | 2.37 | 2.75 | 1.92 | 14.17 |
| Dell 316SX | 1.66 | 1.76 | 1.73 | 1.83 | 2.42 | 2.66 | 1.78 | 13.86 |
| Ultra-Comp Ultra 386SX Appeal | 1.65 | 1.74 | 1.73 | 1.96 | 2.38 | 2.44 | 1.94 | 13.84 |
| Hyundai Super-386s | 1.55 | 1.79 | 1.54 | 1.75 | 2.47 | 2.55 | 1.92 | 13.56 |
| Zenith Z-386SX | 1.34 | 1.48 | 1.78 | 1.77 | 2.33 | 2.90 | 1.60 | 13.20 |
| CompuAdd 316S | 1.30 | 1.55 | 1.65 | 1.62 | 2.35 | 2.62 | 1.80 | 12.89 |
| IBM PC AT[1] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 7.00 |



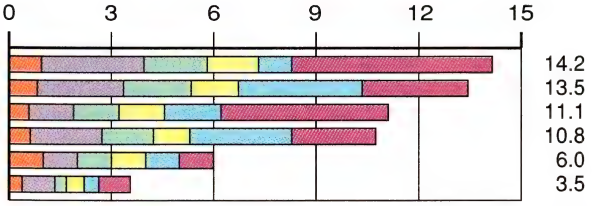
[1] Listed for reference only.

## BYTE BENCHMARK INDEXES—MACINTOSH FAMILY

| Computer | WP | SS | DB | Sci./Eng. | Cmplr. | Applications |
|---|---|---|---|---|---|---|
| Mac IIfx | 6.54 | 6.88 | 5.31 | 25.34 | 5.72 | 49.79 |
| Mac IIci | 5.12 | 4.67 | 4.08 | 9.97 | 3.07 | 26.91 |
| Dynamac | 3.87 | 3.25 | 2.33 | 6.43 | 3.84 | 19.71 |
| Mac IIcx | 2.72 | 3.25 | 3.07 | 6.13 | 2.79 | 17.97 |
| Mac SE/30 | 2.68 | 3.53 | 2.99 | 5.23 | 2.60 | 17.04 |
| Mac IIx | 2.60 | 3.20 | 3.15 | 5.32 | 2.53 | 16.81 |
| Mac II | 2.00 | 2.72 | 2.53 | 4.24 | 2.16 | 13.66 |
| Mac Portable | 1.53 | 1.88 | 1.51 | 2.49 | 1.85 | 9.26 |
| Mac SE | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 5.00 |
| Mac Plus | 0.80 | 0.88 | 0.93 | 0.91 | 0.84 | 4.36 |
| Outbound[1] | 2.61 | 1.94 | 2.48 | N/A | 3.12 | N/A |



[1] The Outbound could not run the Scientific/Engineering suite of tests; therefore, it did not post a cumulative application index.
N/A=Not applicable.



**Mac IIfx**

all tests. The cumulative application index represents an overall score based on the seven application categories, so the AT posts a 7.00.

We tried to test the machines as configured by the vendor, with some exceptions. We disabled any software caching and, for the new benchmarks, installed extended-memory drivers. Machines tested without a coprocessor are listed separately. Every system tested with the new benchmarks has a coprocessor installed (or, as is the case with the i486, includes an integrated FPU).

We discouraged vendors from sending us systems with optional caching disk drive controllers installed, as that inflated the disk I/O and cumulative application indexes. Those machines that have been benchmarked with caching controllers are marked in table 1 with a footnote.

The 40-MHz Mac IIfx leads the march of Mac boxes (see table 4). The 68000 processor inside the Mac SE, the Mac Plus, and the Mac Portable doesn't support an integrated math coprocessor, so those machines could not generate an FPU index. For the same reason, the Mac FPU indexes are referenced to the Mac II, while all other indexes are based on the Mac SE. The Mac indexes should not be compared to the PC indexes.

New for this benchmark roundup are the Unix indexes. Table 5 provides a broad means of comparison among several Unix boxes and Intel-based PCs running SCO Xenix.

Comparing speed indexes is fun, and it can be valuable when deciding among the varieties of CPUs and clock speeds. But speed should not be the sole criterion by which you judge a PC. Construction quality, customer support, compatibility, and price are just as important—perhaps more so, if your application does not require a great deal of performance from the hardware. In the tables, we've referenced the BYTE issue in which the review of each system appeared. If you're using this listing to shop for a PC, please read the full review for the whole picture.

So now we're ready for the latest stream of speed demons. We have the two things we needed most: new benchmarks and a bigger thesaurus. ■

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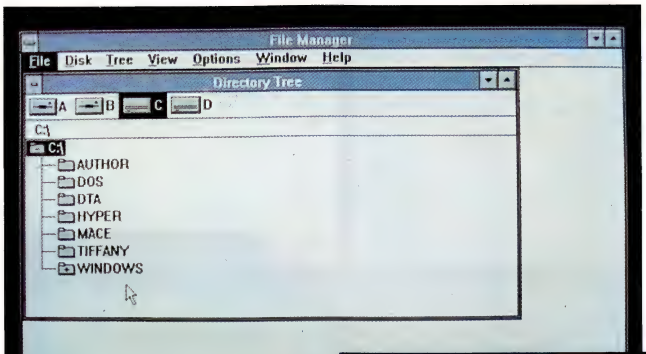
*Stanford Diehl is a BYTE Lab testing editor/engineer. You can reach him on BIX as "sdiehl."*

## FILE MANAGERS

The File Managers of Windows 3.0 and OS/2 are nearly identical at first glance—with Windows again showing the more finely detailed icons. On start-up, Windows 3.0 shows only the top-level subdirectories, while OS/2 displays all directories and subdirectories. (As with other options, every time you start the File Manager, you can easily customize what it shows.)

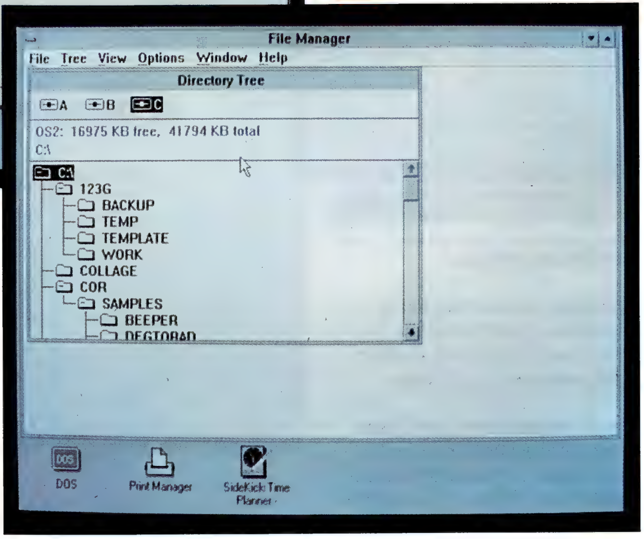
Note that OS/2 is missing a *Disk* pull-down menu in its File Manager. In the Windows 3.0 file manager, this menu contains the necessary copy and formatting commands for floppy disks. Of course, these are available in OS/2, but they're hidden in the Utilities Group. OS/2 also contains a Fixed Disk utility that lets you create and modify hard disk partitions. While useful, it can be dangerous in inexperienced hands (which is evidently why it's missing in Windows 3.0).



Drive C: has 15585280 bytes free.

WINDOWS 3.0

OS/2

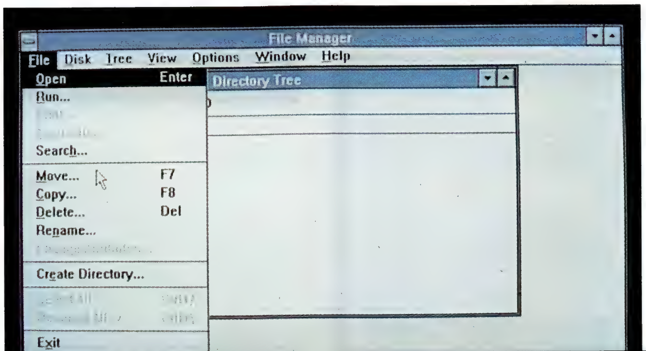


OS2: 16975 KB free, 41794 KB total

## FILE MENUS

You'll spend a great deal of time in the main file pull-down menus of both Windows 3.0 and OS/2. The choices here are nearly identical, with a few notable exceptions. OS/2 contains a *Properties* option that lets you view extended information on your files (e.g., the icon, the subject, the date, and the time last changed). Also peculiar are the *Change Attributes* option in Windows 3.0 and the *Change flags* option in OS/2. Although they have different names, they do the same thing—they let you change the file type (e.g., hidden, system).

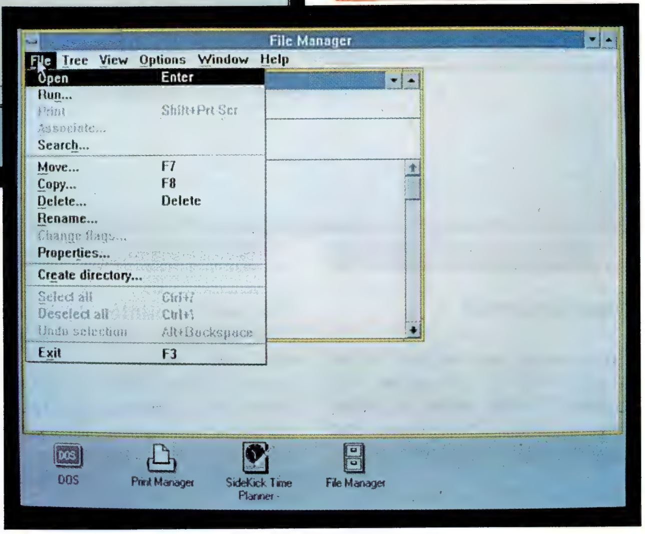
One thing that's still missing from both Windows 3.0 and OS/2 is the ubiquitous Trashcan that Macintosh users have grown to know and love. In both the Windows 3.0 and OS/2 environments, the Delete key does the job, although not as elegantly (if you can call a Trashcan elegant).



Drive C: has 15585280 bytes free.

WINDOWS 3.0

OS/2



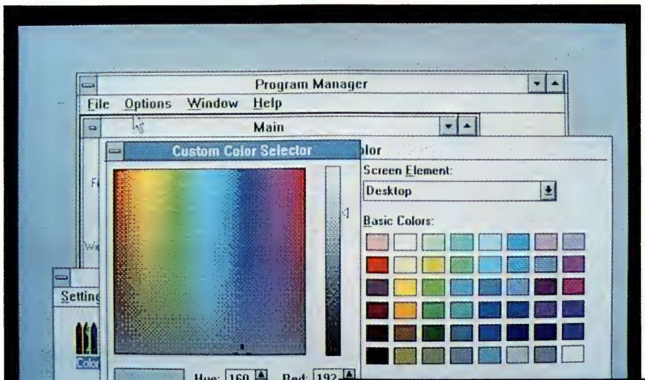
## DESKTOP DESIGN

(a) In Windows 3.0, Microsoft has created nearly limitless options for customizing the look and feel of the desktop. Besides being able to choose basic colors for desktop elements, you can also fine-tune them through a virtually unlimited palette.

(b) Hidden farther down in the menus are options for "wallpaper" (the screen background) and even the patterns that show on the background of individual windows.

(c) Windows' concentration on bright windows and icons almost makes you feel like an interior decorator.

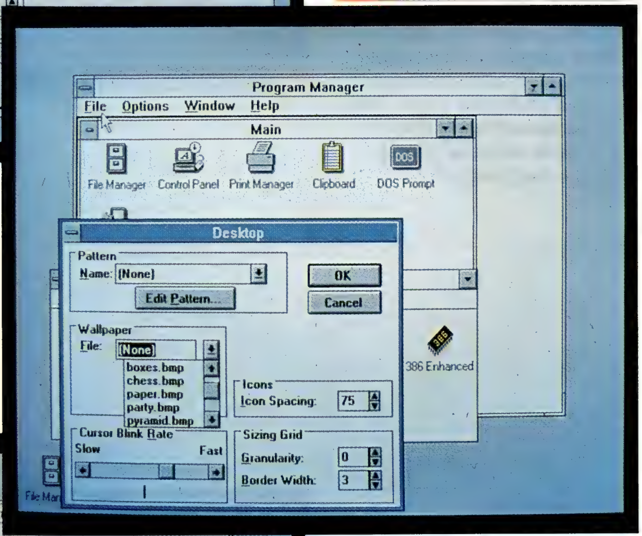
(d) OS/2 offers a severely limited choice of colors for individual screen elements, and no choice at all for screen background patterns. What you see is what you get.



Screen Element: Desktop

Hue: 160 Red: 192
Sat: 0 Green: 192
Lum: 181 Blue: 192

(a) WINDOWS 3.0



Name: (None)

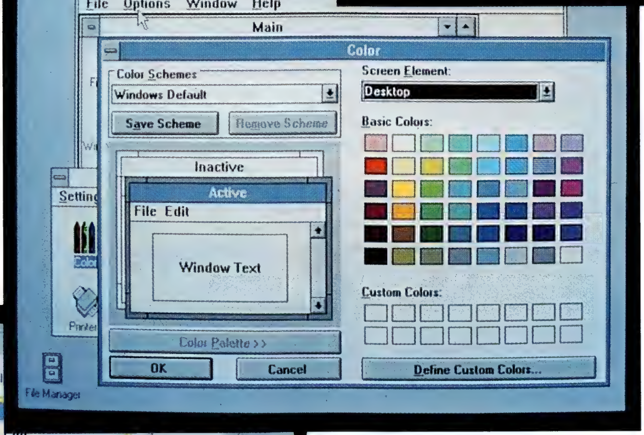
File: (None)

Icon Spacing: 75

Granularity: 0

Border Width: 3

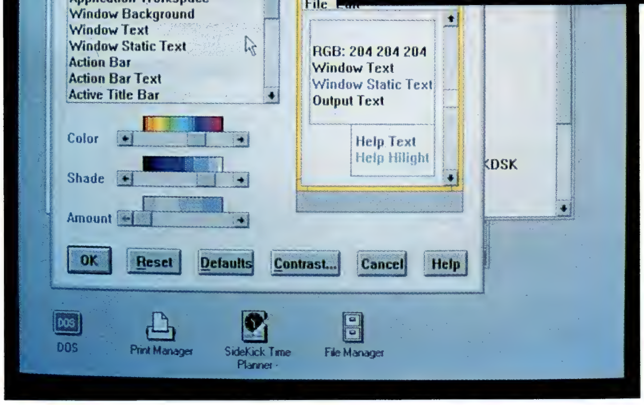
(b) WINDOWS 3.0



Color Schemes: Windows Default

Screen Element: Desktop

(c) WINDOWS 3.0



RGB: 204 204 204

(d) OS/2

with your screen, mouse, and keyboard.

Even though Windows 3.0 and OS/2 come essentially from the same parentage (i.e., the programming gnomes at Microsoft), there *are* some differences. Although at the most basic level, both are Common User Access–compliant—part of IBM's omnibus Systems Application Architecture specification, both packages represent an evolution, with Windows 3.0 the latest incarnation in the march toward the ultimate graphical user interface (GUI) design.

## Fair Comparisons

One thing that people seldom mention in the "Great Windows 3.0 versus OS/2 Debate" is that in certain ways, comparing the two is like comparing apples and oranges. After all, Windows 3.0—at its heart—is simply a graphical DOS shell (albeit a *very* sophisticated one). OS/2, on the other hand, is much more a full-fledged multitasking, multithreading operating system. That crucial difference is the reason that you interact with Windows 3.0 and OS/2 differently.

What follows is a gallery of comparisons that show some of the key user interface differences (and consistencies) between Windows 3.0 and OS/2. Like a gallery owner setting up an art show, We've chosen the best—the highlights of what have become (for better or worse) the leading GUIs of the PC world. Not only do both environments have hundreds of screens and pull-down menus, they're also highly customizable to fit your own preferences and graphical prejudices.

Your ultimate choice of an operating environment depends on a wide range of factors, including your needs and the size of your wallet. But like choosing a car, when you have to live with a system from day to day, the ultimate question is: "How well does it drive?"

What of the future? OS/2 2.0 (for 386- and i486-based systems only) will probably have many of the graphical elements of Windows 3.0. OS/2 2.0 is due at the end of the year. Time will tell. ■

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*Stan Miastkowski is a BYTE senior editor. He can be reached on BIX as "stanm."*

*Circle 51 on Reader Service Card (RESELLERS: 52)*

Space-Saver Keyboard

Save an amazing 60% of the desk or counter space now taken by a standard keyboard and enjoy improved functionality at the same time. Actual size is 10.75″ x 6.0″ (273 x 152mm). The new MICROTYPE keyboard is rapidly gaining acceptance as a truly advanced alternative to the original IBM layout for many applications. Reliability of the MICROTYPE has been amply proven through extensive use in trading areas of the NYSE, The New York and Chicago Mercantile Exchanges as well as in many banks, brokerages, stores and at factory work stations.

Space is saved by compressing rows (not columns) and eliminating wide borders. Re-arranging and elevating the auxiliary key clusters also saves space while improving accessibility with reduced eyescan and head movement. Keys have full travel with a light tactually responsive touch. All standard features such as auto-repeat, caps, num and scroll lock are included on the MICROTYPE.

PC XT/AT, PS/2 IBM and clone compatibility. Available in US and most European language versions. Made in USA with 1 year warranty.

. . .beautifully sensitive and handles both typists with light touch and those who really bang away. . .
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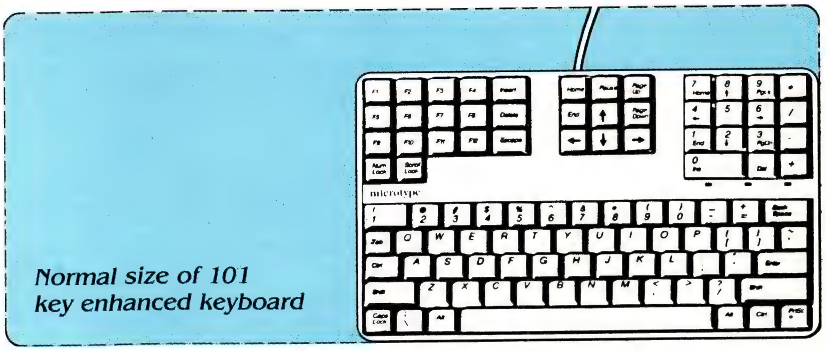

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# STRANGER IN A STRANGE LAND

*It's easier than you might imagine to share information among the Macintosh and other personal computers*

Tom Thompson

Just a few years ago, it was an uphill battle to get an Apple Macintosh computer through a corporation's doors. Now, they can be found peppering desktops in offices everywhere. No, they haven't taken over: Many tasks are better handled by PCs. But the Mac *earned* its spot on a desk, simply because its superior graphics capabilities produced professional artwork (e.g., charts, figures, and logos) better and faster than your garden-variety PC.

But as the Mac uniquely solves some business problems, it also adds some complications. You might, for example, want a Mac program to draw a chart that uses numbers computed on a Compaq Deskpro. Ideally, this should not be a problem. Practically, however, the disparate file formats that exist between PCs and Macs—and even among programs on the same computer—can make achieving this ideal a major headache. Suddenly, the Mac appears like a stranger, speaking in an unknown tongue.

But information sharing between PCs and Macs is not impossible. How the Mac handles data isn't that much different from how a PC handles it, although it may seem that way when you hear Mac folks talking about a file's *data fork* and *resource fork.* If you understand how the Mac handles data, you can convert a file's contents into something that any machine can use. Furthermore, a number of vendors (e.g., Microsoft, Aldus, and WordPerfect) have written programs that operate on both Macs and PCs while using the same file format.

I'll start by showing how to exchange files between Macs and PCs. I'll gloss over networking solutions, since implementing these is an article in itself. I'll discuss ways to make use of the file's information, whether you're using it on a Mac or sending it to a PC. Along the way, I'll provide hints on potential problems, even if you're using a vendor solution like Microsoft Word.

## Dealing with Disks

Trying to move a file from a PC floppy disk onto a Mac floppy disk used to be a major chore, even though both machines use the same 3½-inch floppy disks. That's because each computer uses a different data-encoding method to record information.

The PC uses MFM for its floppy disks, while the Mac uses group-code recording (GCR). The end result is that neither computer reads the other's disks. In a large office, a network (e.g., Novell NetWare or Dayna Communication's DaynaNET) that links both computers bypasses this problem, but for a small office there used to be no easy solution.

The need for data exchange

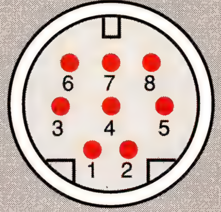
*continued*

ILLUSTRATION: DON BAKER © 1990

DEM, and ZMODEM transfers usually want the sending machine ready to go before the receiving machine starts. There might be a delay as the computers synchronize the transfer, but the file should then be transmitted rapidly. It might take you several attempts to get the hang of this, but once you do, you'll be able to move files easily from one system to another.

If all this sounds daunting, a variety of packages on the market can assist you with serial transfers. Both DataViz and Traveling Software offer packages (MacLink Plus/PC and LapLink Mac III, respectively) that include both software and a special serial cable.

**MAKING MAC-PC CONNECTIONS**



| Macintosh signal | Mini DIN-8pin | RS-232C pin |
|---|---|---|
| Output handshake | 1 | No connection |
| Input handshake | 2 | 20 for ImageWriter, not connected for PC |
| Transmit data (TxD-) | 3 | 3 |
| Ground | 4 | 7 |
| Receive date (RxD-) | 5 | 2 |
| Transmit data (TxD+) | 6 | No connection |
| No connection | 7 | No connection |
| Receive data (RxD+), ground for RS-232C emulation | 8 | 7 |

**Figure 1:** *The schematic for a null modem cable to connect the serial ports of a Macintosh and an IBM PC. You can order an ImageWriter II extension cable and cut it in half to obtain the male DIN-8 connector. The DB-25 connector is available from most electronics stores.*

## Same Data, Different Machine

Now that you've got that PC file on a Mac (or vice versa), it's time to make use of it. You'll have little difficulty if you use a program like PageMaker, which runs on both machines. For other programs, some preparation might be necessary. I used a Compaq Deskpro 386/20 running Windows 2.11 to generate PC files that I transferred to either a Mac II or Mac IIfx to evaluate just how difficult it is to use data generated on a different platform. As long you work within the limits of both machines, sharing information can be surprisingly easy.

I just mentioned PageMaker, and for good reason. Its interface is consistent on both computers, and there has never been a problem with exchanging its files. While there are other page-layout programs, PageMaker's reliable performance across diverse machines is an asset. It runs faster on an equivalent PC than on a Mac II, which means that for some page-layout work you're better off using PageMaker on a PC.

Be certain to use the same version of PageMaker on both computers: The file format differs slightly from version to version. That is, you can exchange files between a Mac and a PC if they're both running PageMaker 3.0. But if you're using PageMaker 1.0 on a PC and PageMaker 3.0 on a Mac, a file exchange won't work. You'll have to upgrade the PC version of PageMaker to ensure file compatibility.

If you're using PageMaker on the Mac to incorporate different PC files (e.g., scanned images or PostScript figures), you'll have to modify the file's type so that PageMaker recognizes the file's data format. See the text box "A Matter of Type" on page 92 for details.

The PC version of Autodesk's AutoCAD (release 10c2) had no difficulty reading Mac AutoCAD files, nor did the Mac version (release 10c5) with PC files. WingZ for OS/2 and Windows 3.0 shares the same files with the Mac version. The same is true for Microsoft Excel: Its files are completely interchangeable between Excel 2.1 (PC) and Excel 2.2 (Mac). No file conversions were necessary, and the transfers were painless.

However, Microsoft complicated the situation with its word processors. First, there are two PC versions: Word 5.0, for a command-line interface (CLI) environment, and Word for Windows 1.0, for a graphical user interface (GUI) environment. On the Mac, there's Word 4.0. The different version numbers aren't so bad. However, if you misstep with the file format when saving the document, you wind up with a file that can't be used elsewhere.

The Word 5.0 file can be opened directly by Word 4.0 on the Mac. But if you're using Word for Windows 1.0 for its WYSIWYG display, be sure to save the file *not* in its default format (Normal), but as Word for DOS. On the Mac, you should configure Word 4.0 for Full Menus. When you save the file, click on the File Format button in the Standard File dialog box. Select the MS-DOS—not Normal—format and then save the file. Both Word 5.0 and Word for Windows 1.0 will read this Mac file and restore the formatting.

It sounds more complicated than it actually is, but as long as you remember to save the files in MS-DOS Word format, you will have no problems exchanging files. WordPerfect's word processors (5.1 for the PC and 1.0.4 for the Mac) have a similar gotcha: Save both as WordPerfect 5.0 documents.

Adobe Illustrator also has its share of quirks when it comes to file exchange. Illustrator 1.9.3 on the Mac readily accepts files from its PC cousin, Illustrator 1.0. However, when you save an Illustrator file for export to the PC, you first need to save it as a version 1.1 file (there is a version format problem similar to PageMaker's). Also, don't save the file with a preview (i.e., a bit-mapped image used to help place the graphic in a page-layout program).

Be aware of some differences between the two programs. On a Mac, you can add color to your artwork and view it (see photo 2) and have access to a blend tool (for blending colors).

On the PC, you can add color to the artwork, but your results will be guesswork, since you can preview the artwork only in shades of gray (see photo 3). And there is no blend tool. Also, you lose some information in a Mac Illustrator file when you convert it to transport to the PC.

A lock function, which is used to prevent the selection of overlapping objects,

*continued*

# They Left out Features....
# We Left out the COMMA!!

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| VersaCAD Design 5.4 | $ 2,995.00 | N/A |

Source: Byte Magazine

## The only thing missing...

is the comma in the price. If you look at the chart on the right you will see prices charged by our competition. All but one contain a comma. DesignCAD 3D sells for $399.00. Period. No Comma!

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> *May 1989, page 178*

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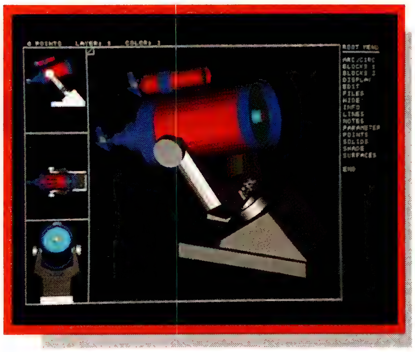

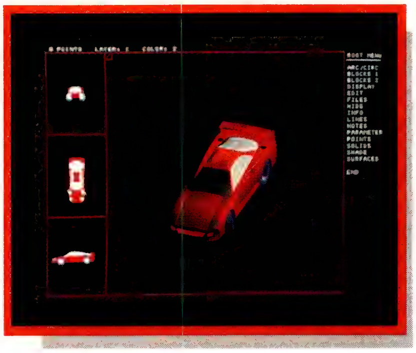

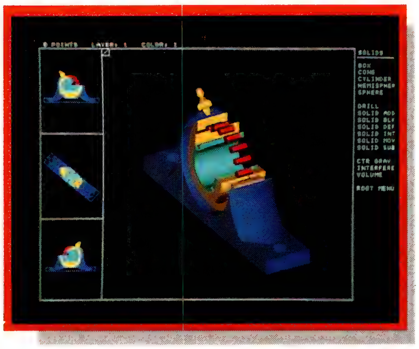

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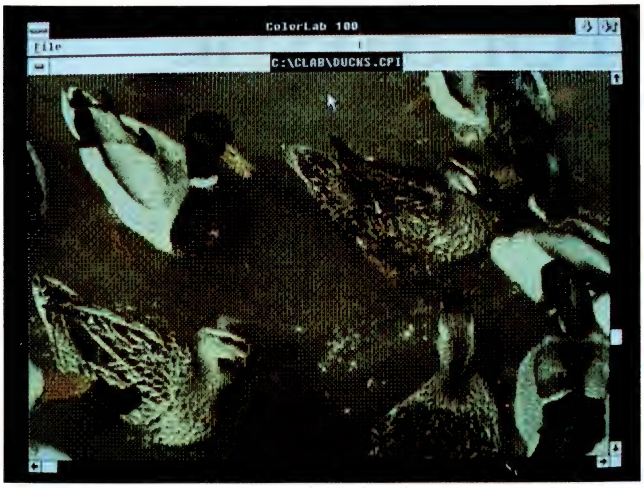

**Photo 4:** *An image scan on a Sharp JX-100 scanner using ColorLab 100 scanning software on a Compaq Deskpro 386/20.*

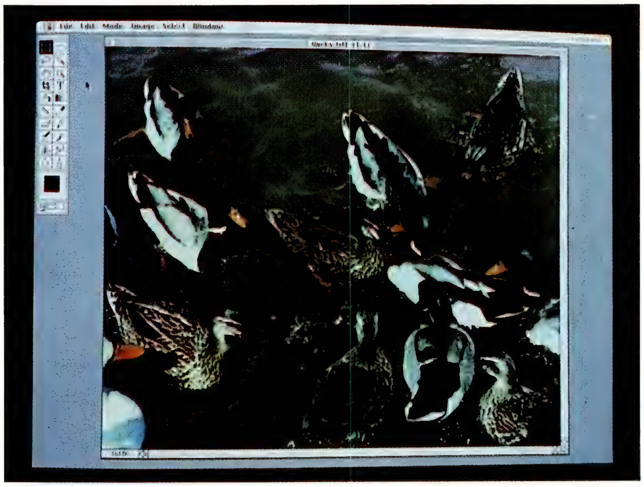

**Photo 5:** *The image in photo 4 was saved as a 24-bit TIFF file and transported to a Mac II. The image is being viewed with Adobe Photoshop using a 24-bit color SuperMac video board.*

formatting information, but quite often text transfers are done so that the receiving computer can merge the text into one document. You then add the typefaces, style, and graphics to this combined document. Where and with what program you finish the document doesn't matter: It could be PageMaker on either machine, Quark XPress on the Mac, or Ventura Publisher on the PC.

Also, tab-delimited text (i.e., ASCII numbers separated by tab characters) is useful for shipping tables of numbers. For example, those Compaq numbers mentioned at the start of this article can be saved as a tab-delimited table, which you send to a Mac. Cricket Graph can read tabular data in this format and produce a graph of the information in a matter of minutes.

When moving files from the PC, remember that its ASCII text files normally end with a carriage return/linefeed pair. On the Mac, text files end with just carriage returns. So remember to strip or add the linefeeds as you move raw text from one machine to the other.

*PostScript* is a fairly reliable means of exchanging graphics. Here at BYTE, we have moved graphics between Unix systems, PCs, and Macs using PostScript. Since PostScript commands are text-based, you can use ASCII file capture to move files around in a pinch.

However, Illustrator gets downright cranky when you try to get it to read PostScript files not made in Illustrator. The same goes for Encapsulated PostScript files: Some programs will read them; others won't. Since there's no reliable way to determine beforehand what files cause problems, you'll just have to experiment until you hit on a working combination of programs and settings. Or, stick with Illustrator exclusively.

*TIFF* was originally developed by Aldus to transport bit-mapped images across different computers. The specification is now in the public domain and is maintained by a number of vendors. It's also a reliable exchange medium. I've scanned images on a PC using a Sharp JX-100 scanner (see photo 4) and Computer Presentations ColorLab 100 software. I had ColorLab 100 save the images as 24-bit TIFF files and then transmitted the files to the Mac. On a Mac II equipped with a SuperMac Technology 24-bit color video board, the results—created on a PC—can be spectacular (see photo 5).

The biggest problem with TIFF files is how well vendors implement the specification. Some programs handle only 1- or 8-bit TIFF files, so that a 4-bit TIFF file (from a NeXT Computer) or a 24-bit TIFF file (from either a Mac or a PC) causes them to crash and burn.

Other potential problem areas in the specification are data compression and how the image is stored. In the latter case, the Motorola processor organizes its data in the reverse from how an Intel processor handles data storage. This potential problem is dealt with by information in the TIFF file that describes its data organization. A decent TIFF reader can read this information and reorganize the data as it accesses the file. Some programs don't. As is the case with PostScript, you'll have to experiment with various programs to see what works.

Finally, check to see what formats your target program can accept. Data compatibility might be just a matter of looking in the manual. For example, many Mac spreadsheet programs can read PC files saved in the SYLK format. Word and Word for Windows can save Rich Text Format files that describe the document's typeface and style information as text commands. These RTF files can be read by WriteNow or MacWrite II on the Mac, via filters.

## Medium of Exchange

As you have seen, the Mac no longer works in isolation from its PC and workstation counterparts. Programs are available that let office workers use the same set of keystrokes and mouse actions to do the job, no matter what type of microcomputer they're using. Furthermore, copying files back and forth is no longer a nightmare. Instead, it's a convenient way to move the information from one user to the next. Even if you don't use WordPerfect, Illustrator, PageMaker, or the like, exchanging data is now more a science than an art.

Macs and PCs give today's office the best of both worlds. PCs can be used to their best advantage, and so can Macs. The ability to easily exchange information between the two creates a synergism resulting in work that's better than anything done by a single type of computer. Because information is easily shared nowadays, the Mac isn't a stranger in the office. Rather, it is an important ally in dealing with the Information Age. ■

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*Tom Thompson is a BYTE senior editor at large with a B.S.E.E. degree from Memphis State University. He can be reached on BIX as "tom_thompson."*

# PROGRAMMING 32-BIT OS/2

## *Working with the OS/2 2.0 SDK*

*Martin Heller*

As the next generation of operating system for personal computers, OS/2 2.0 has generated more than its share of media attention. What I'd like to do here is to strip away the hype and speculation and get down to the bare facts. I am working with the OS/2 2.0 Software Development Kit (SDK). This is a $2600 product that allows developers to use early versions of the operating system and development tools to prepare their applications.

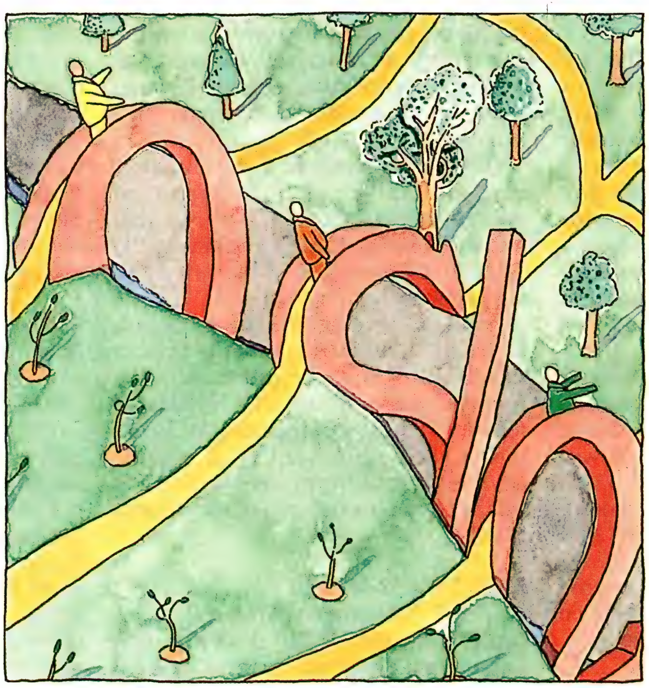
### Just the Facts, Ma'am

OS/2 2.0, a multitasking, single-user operating system for PCs, is based on the Intel 386 and i486 CPUs. It builds on the technologies found in earlier versions of OS/2 and in Windows/386. OS/2 2.0 offers many features:

- linear or "flat" 32-bit memory model
- paged virtual memory
- full use of the 386 instruction set
- support for existing DOS and OS/2 1.2 16-bit applications
- multiple virtual DOS machines (MVDMs)
- High Performance File System (HPFS)
- extended file attributes
- long filenames
- greatly expanded system limits
- support for Windows applications through the SMK

### C Programming Models

OS/2 2.0 supports multiple programming models. Applications written for the Presentation Manager and built with the 32-bit tools have full access to the PM's user interface and graphical programming services. These applications will run only under OS/2 2.0 (although you can build 16-bit versions from the same sources to run under OS/2 1.2).



Character-mode applications don't need to use the PM to get the advantages of the flat 32-bit memory model. These programs are written using the C run-time library facilities and built with the 32-bit tools; they can also use the OS/2 2.0 application programming interface. Character-mode 32-bit applications (e.g., 32-bit PM applications) will run only under OS/2 2.0. Again, you can build 16-bit applications from the same source code—but if you use OS/2 2.0 APIs, you will need to make some adjustments so that they will be compatible with the OS/2 1.2 APIs.

The 32-bit model paves the way for a lot of Unix programs that haven't yet been ported to OS/2. That's mainly because Unix code assumes that pointers can look anywhere in memory, whereas OS/2 1.x programs target an architecture made up of many small, protected segments. OS/2 2.0 eliminates

*continued*

ILLUSTRATION: PAUL FISCH © 1990

for your day-to-day development.

Note that in the example of `DosAllocMem` I used the `PAG_COMMIT` flag to commit all the memory allocated. To allocate sparse memory, you would leave out the `PAG_COMMIT` flag and change the access of selected pieces of the allocated object with `DosSetMem`. You can decommit memory in the same manner. For example, you may want to allocate and fill a large memory buffer for print spooling and then decommit pages once you have printed the contents.

Another effect of the change from segment-based memory management to object-based memory management is the need to modify device drivers. In practice, you must revise base device drivers (e.g., disk drivers) to use 32-bit `DevHlps` (operating system services made available to drivers), but mouse drivers from OS/2 1.2 should work properly. Screen drivers from version 1.2 will most likely work under version 2.0, but they won't support EGA or VGA graphics in virtual DOS machines until you update them. It should not take long for you to update screen drivers for OS/2 2.0. Printer drivers from OS/2 1.2 may or may not work in version 2.0, depending on how they do their memory management.

### Semaphores

Semaphores are system "flags" used to coordinate multiple tasks. There were several problems with the design of semaphores in OS/2 1.x. Many of the problems in OS/2 1.x occurred because a single type of semaphore was being used for multiple purposes. The 32-bit semaphore functions in OS/2 2.0 use a different design that should solve these problems, although the 16-bit semaphore functions are unchanged for compatibility. In addition to the new semaphore APIs, the total number of system semaphores was increased greatly, to 64 shared plus 64 private per process. OS/2 2.0 has three separate types of system semaphores: mutual exclusion (mutex), event, and multiple wait.

Mutex semaphores are designed to be used by several threads within a process, or by several processes, to protect access to a critical region. A typical use would be to prevent more than one thread at a time from updating a file on disk. Only one thread at a time can own a mutex semaphore. The OS/2 kernel blocks threads that are waiting for an owned mutex semaphore and queues multiple requests for a single semaphore. This grants ownership on a first-come, first-served basis.

*Mutex semaphores are designed to protect access to a critical region.*

Event semaphores have two states: reset and posted. They provide a signaling mechanism among threads or among several processes. You might typically use them to manage shared memory: Process 1 writes into the shared region and then uses a signal semaphore so that processes 2 and 3 can proceed to access the shared data. A little thought will convince you that what is fail-safe behavior for an event semaphore is unsafe for a mutex semaphore, and vice versa.

Multiple-wait semaphores are designed to allow a thread to wait on several mutex or event semaphores at once (although all the semaphores in the multiple wait must be of the same type). A typical use would be a thread that requires access to several shared regions of memory at once. By using a multiple-wait semaphore, the thread can block until the system has gathered ownership of all the regions. The thread can then proceed to process the data, while being assured that the critical resource is protected from all other threads.

The multiple-wait mechanism is important because it avoids deadlock situations. Suppose, for instance, that a multiprocess transaction-processing system needs simultaneous access to both the debit and credit ledgers. Transaction A may gain access to the debit ledger, while transaction B gains access to the credit ledger. Neither transaction will be able to complete, and neither will yield. However, if you use multiple-wait semaphores, and the transactions block until both ledgers are available, each transaction can proceed in turn.

### Threads and Processes

The OS/2 2.0 `DosCreateThread` is more convenient than its 1.2 counterpart. To begin with, you can now pass a single doubleword argument to the thread—which can be the address of an argument list. You can start the thread in either the active or the suspended state. Best of all, the system automatically allocates stack for the thread.

The automatic stack allocation is not initially committed beyond the first 4K-byte page, so the application can ask for a large stack without a performance penalty. When the stack grows down to the guard page, the system will automatically create more stack space by committing the guard page and moving it down.

A few other minor problems have been cleared up. A new error code to `DosKillProcess`, "Process is Zombie," reflects the situation of a process that is dead but hasn't been reaped by its parent. And a new function, `DosWaitThread`, allows one thread to wait for another to die.

### Queues and Anonymous Pipes

The 32-bit queues in OS/2 2.0 look very similar to 16-bit queues—at least on the functional level. However, the system resources that they create are not the same. 32-bit queues are completely incompatible with 16-bit queues. You cannot read or write 32-bit queues with 16-bit functions, nor 16-bit queues with 32-bit functions. In practice, this is not likely to be a severe restriction, since you could write a 32-bit "bridge" task that could connect a given 32-bit queue to a 16-bit queue.

The OS/2 1.2 function `DosMakePipe` is called `DosCreatePipe` in version 2.0. These two functions do the same thing. The 64K-byte restriction on the advisory size is removed in the 32-bit version; this can be a benefit if you really need to create a large pipe (e.g., if you want to pipe a fast stream of real-time data into a process to analyze and save the data). In this case, you wouldn't want the real-time process to block just because a pipe filled up, because that would mean losing data.

### MVDMs

One of the major enhancements in OS/2 2.0 is support for MVDMs. An MVDM tries to make a user's transition from DOS to OS/2 relatively painless: It supports major DOS applications, protects the system from the cavalier way DOS programs sometimes act, and provides performance that is as good as or better than that of DOS.

DOS programs typically assume that they are all alone in your computer and can use whatever resources they can find. For instance, a DOS program will typically look at the ROM data area to determine the computer's configuration and then stuff bytes directly into video memory to write on the screen. DOS programs don't have to worry about refreshing their displays on demand—they

*continued*

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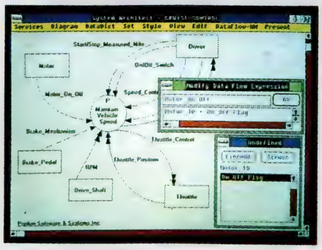

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# MULTIMEDIA: DVI ARRIVES

*The promise of DVI is becoming realized with commercial products by IBM, Intel, and third-party developers*

*Greg Loveria and Don Kinstler*

The Mayans flourished for more than 1000 years on the Yucatan Peninsula in Mexico before their culture crumbled in the sixteenth century. Now, thanks to Digital Video Interactive (DVI) technology and New York City's Bank Street College, the Mayan civilization can return to life with a single keystroke.

Bank Street College's CD-ROM program, called the Palenque Museum DVI application, provides just one example of how DVI is being developed today: in this case, for surrogate travel. For example, if you select the Palenque application's Rain Forest Room icon, the exotic flora and fauna of the Yucatan Peninsula move across your VGA screen. If you click on an ant icon (appropriately located on a tree's leaf), you'll see a 30-second video and audio explanation of leaf-cutting ants at work.

Other sequences take you up the steps of a Mayan ruin. From there, you can look 360 degrees around, up, or down, just as if you were actually there.

While some computer veterans scoff at the publicity that currently surrounds multimedia, the melding of digital video and audio is producing concrete results for many areas (e.g., armchair travel, education, industrial training, and business presentations). According to Kathy Wilson, the Palenque project's director, a consumer version of the application will be available in the second quarter of next year.

Bank Street College is also working with the Metropolitan Museum of Art and the Chicago Art Institute to develop similar applications for the fine arts. The first implementations of these art databases will appear in interactive touch-screen kiosks for museum visitors.

The kiosks will use a combination of DVI technology, videodisk players, Targa boards, and hard disks. These applications may later be ported down to consumer DVI software releases on CD-ROM.

## R&D Roots

While IBM, Intel, and others champion DVI, there are other technologies for melding digital sight and sound (see "The Four Multimedia Gospels," February BYTE). Proponents of other platforms, including those of the Amiga and the Macintosh, believe that those approaches may better exploit the multimedia market.

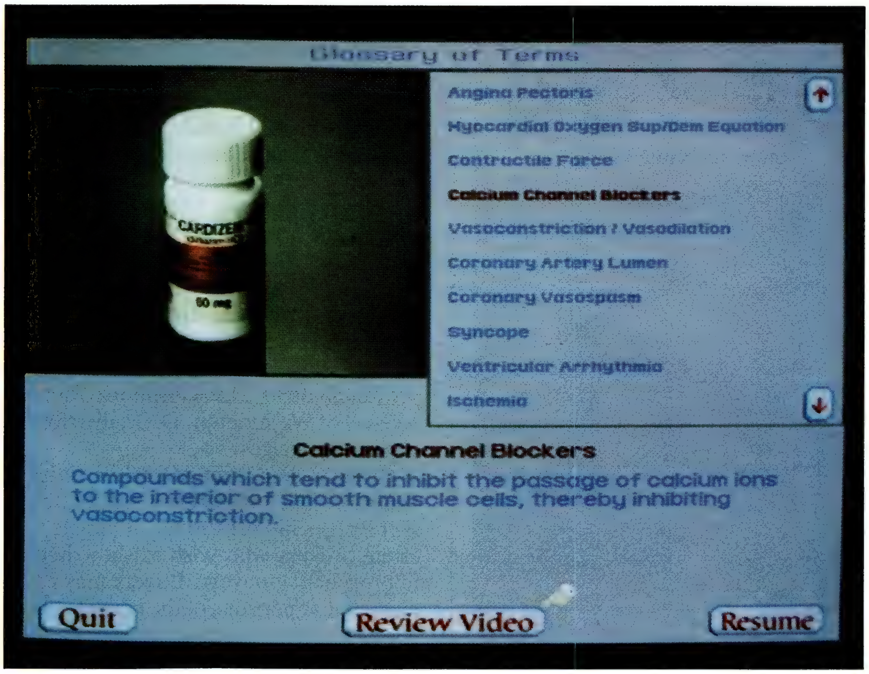
Nevertheless, DVI's roots are firmly established. They reach back to 1982 when RCA and General Electric engineers began their R&D efforts. Intel announced its commitment to the technology in 1987.

DVI technology is now owned by Intel and is under

continued

ILLUSTRATION: ROBIN JAREAUX © 1990

original file size of 720K bytes. This allows a typical CD-ROM disk to store 72 minutes of DVI-compressed motion video and stereo audio information. (The same CD-ROM disk could store only 28 seconds' worth of uncompressed data.) However, CD-ROM access speeds are slower than hard disk data-retrieval speeds (approximately 1 second versus 20 milliseconds, respectively). DVI's 4.5K-byte compressed frame files can be streamed off the CD-ROM fast enough for real-time decompression and display.



Calcium Channel Blockers

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**Photo 2:** *Anderson Consulting's DVI-based medical application trains medical workers about the effects of prescription drugs on the heart. If a technician encounters an unfamiliar medical term, a click on an icon displays information about the subject.*

## Saving Changes

In addition to motion video, the DVI format can compress big collections of still images (e.g., photographs or artwork). Resolution and antialiasing (often referred to as the *jaggies*) for still images is more critical than for motion video. Therefore, DVI compression ratios are generally only 25 to 1 for stills (versus the 160 to 1 possible for moving pictures).

This noticeable difference in compression ratios is due to the way DVI stores full-motion images. In several successive frames of motion video, very little of the picture may change from one frame to the next. Since storing all this redundant information over and over serves no purpose, the DVI system only stores the *changes* in each successive frame to keep the video file size to a minimum. For example, the DVI system would update a dancer twirling onstage but would not update the motionless stage background. The DVI system is smart enough to know when the scene has changed too radically for this method to work (e.g., panning the camera) and will store another "reference frame" from which successive mini-frames can again be interpolated.

Another phenomenon that helps to reduce motion-video file size is the human eye's inability to focus accurately on a moving object's edges (versus the focusing ease and closer scrutiny of viewing a still image) Because of this, antialiasing requirements can be lower for motion video than for still frames. Combined with the motion compensation technique—and other algorithms like it—these algorithms allow the huge compression ratios possible under DVI.

At present, DVI motion video has around 200 lines of resolution, which is less than VCR quality. Users who require higher DVI quality can use Production Level Video (PLV), which is VCR quality. For PLV quality, you must send your audio/video master tape to Intel's DVI/PLV production service, where a powerful mainframe compression system generates DVI files. The PLV service creates CD-ROM masters used for duplicating application disks for mass distribution. The average cost for PLV service is about $250 per running minute of final videotape. Both the PLV and Real Time Video (RTV) lose some focus, and colors tend to smear somewhat during playback.

As high-definition TV looms on the horizon, Intel's goal is to have RTV meet near-TV standards and PLV to meet TV-quality levels (512 scan lines) or even HDTV quality by 1992. HDTV offers resolutions of 1050 lines (consumer grade) or 1125 lines (broadcast production equipment). Since DVI is digital, you can theoretically scale it to almost any resolution factor. Some observers believe that HDTV screens may well be lurking behind present-day VGA monitors, with technologies like DVI evolving to leapfrog HDTV's line resolutions.

Standards committees, such as the Moving Pictures Expert Group, coordinate and implement video standards. One MPEG member mentioned that the group is targeting video compression/decompression quality levels to exceed the current resolution of motion picture film—around 4000 lines. Instead of receiving two to three large reels of 35mm motion picture film, movie theaters would be able to receive the latest box office hit from Hollywood on a DVI encoded CD-ROM.

As communities meld existing telephone networks to fiber-optic links, cable companies will broadcast compressed video data. Instead of visiting the local video store, you'll download your choice of movie titles over the fiber-optic network.

## Commercial and Educational DVI Applications

In addition to the Palenque tour, many other commercial and educational DVI applications are out. Applied Optical Media Corp.'s truck-driving safety simulation consists of an enclosed truck cab kiosk with a brake pedal, steering wheel, accelerator, and dashboard controls. Students face various DVI-based driving sequences similar to what they might see from the cab of an 18-wheeler, including full-motion video running in rearview side mirrors. AOMC is scheduled to ship about 27 of the simulations by 1991. Interestingly, the DVI boards in last year's simulations cost $9500, while the DVI technology going into the 1990 units costs just $2500. This is a price reduction of more than two-thirds in 12 months.

AOMC's Photobase and MediaSource disks are databases containing over 2000 DVI format images on CD-ROM. These

*continued*

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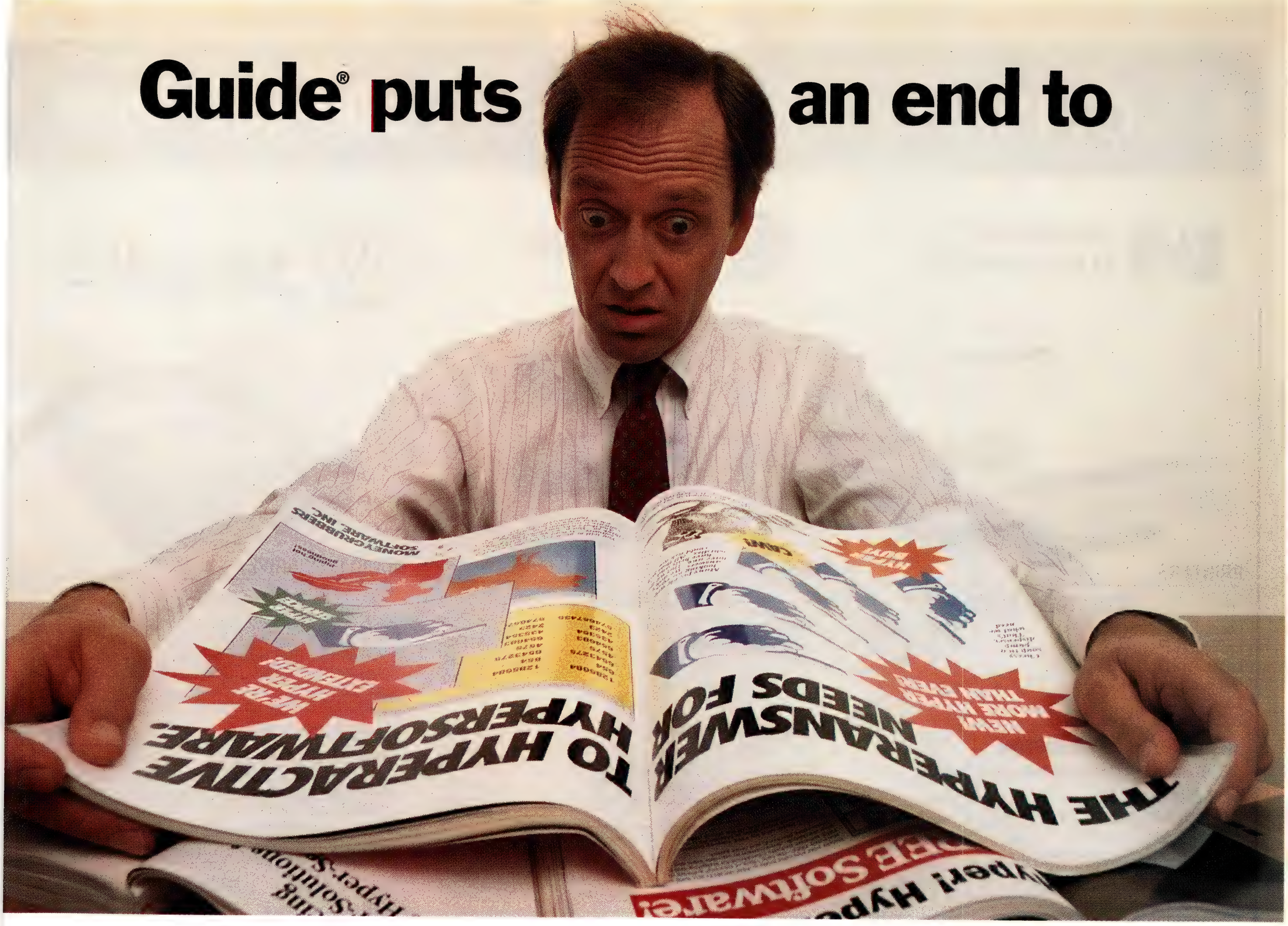
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# DPMI: THE DOS PROTECTED MODE INTERFACE

*A new standard provides binary compatibility for protected-mode applications*

*L. Brett Glass*

In the April installment of Under the Hood, I described the way DOS extenders surmount the limitations of DOS by allowing programs to run in protected mode. I limited my discussion to situations where an extended DOS application could safely take complete control of the machine—that is, I assumed that no multitasking or protected-mode environment was running. This, of course, is not the case in many real-life situations. When you fire up Desqview, OS/2, or Windows (in standard or extended 386 mode), you don't want to lose the ability to run extended applications. By the same token, you don't want to give an extended application the ability to destroy other applications' data structures, stop applications from multitasking, or crash the whole system.

The Virtual Control Program Interface was developed by Quarterdeck Office Systems (developer of Desqview), Phar Lap, and other vendors of multitaskers and DOS extenders (see "Stretching DOS to the Limit," *IBM Special Edition*, Fall 1989). VCPI is a set of conventions that allow extended DOS applications to run in the presence of multitasking environments and memory managers (such as QEMM) that put the 386 into virtual 8086 mode. It works well for its intended purpose; however, VCPI does not prevent the extended application from exhibiting destructive behavior.

An application that uses VCPI runs at ring 0, the most privileged level of the Intel protection scheme. It has access to all of the machine's resources and can take over at will, potentially causing data in other sessions to be lost. Microsoft correctly noted that extended-DOS applications should really run in ring 3—the least privileged level—if they are to coexist with other programs and work with multitasking environments. It's also appropriate for extended-DOS applications to *ask* for the use of system resources rather than simply commandeer them. The authors of "DOS boxes" for Unix concurred. On Unix systems, which can serve many users, it's especially important that the kernel retain full control over the machine's resources. Thus, the DOS Protected Mode Interface was born.

Some DOS-extender vendors grumbled when Microsoft told them about DPMI. They feared, with some justification, that Microsoft might use it to stifle environments that could compete with Windows or OS/2. However, a series of DPMI summit meetings—attended by Borland, Eclipse, IGC, Intel, Locus, Microsoft, Phar Lap, Phoenix, Quarterdeck, and Rational—produced a published standard to which all members agreed. This was

*continued*

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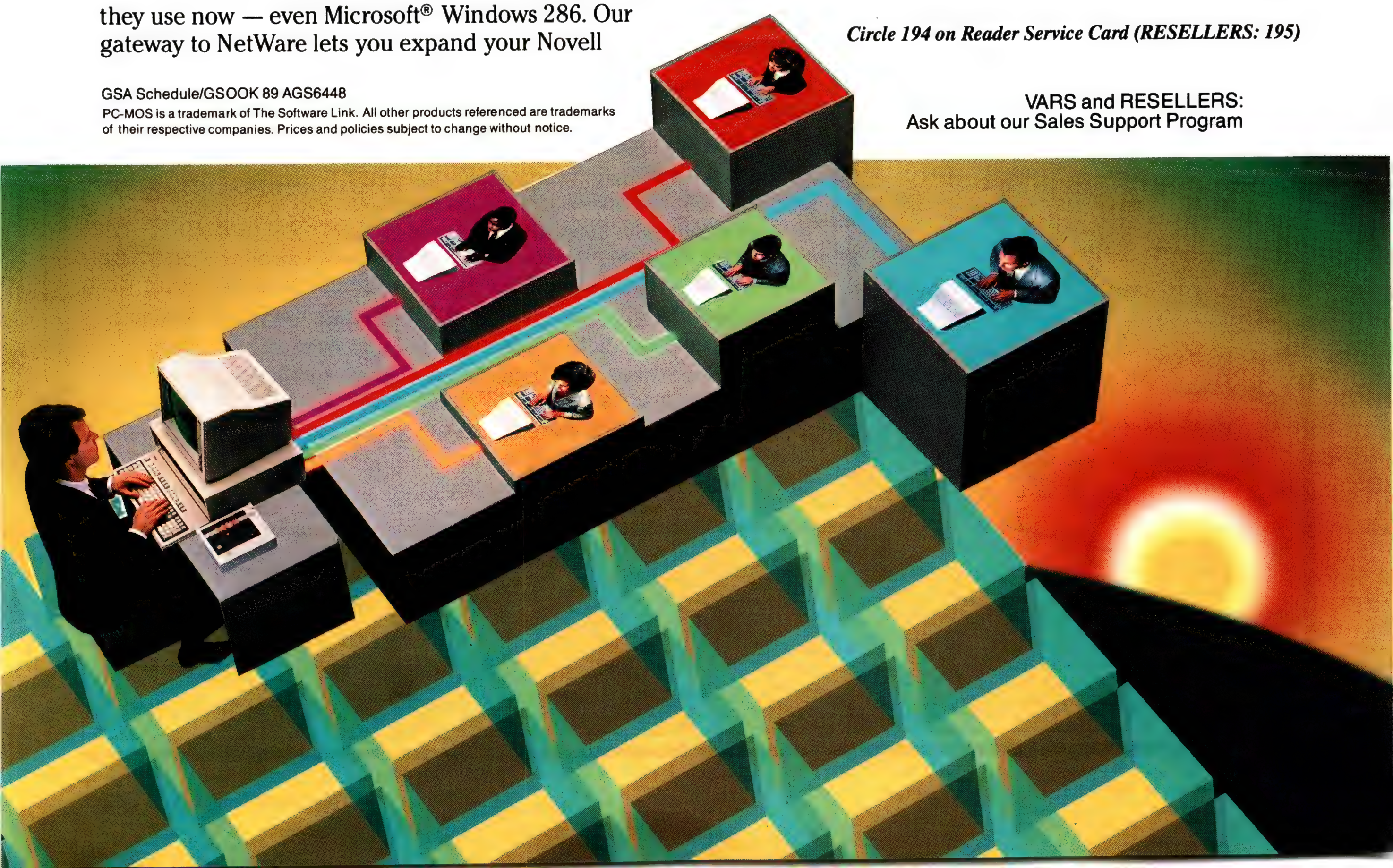

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# OPTICAL STORAGE PRIMER

*What you need to know to take advantage of the most significant advance in computer storage since the floppy disk*

David A. Harvey

Once considered little more than a fringe technology, optical storage devices for personal computers have hit the mainstream with a vengeance. They enable you to store—at a minimum—hundreds of megabytes of data. In fact, devices that store over a gigabyte are not uncommon, and even terabyte storage is available through disk-changing systems (the so-called "jukebox" systems). The question is: What do you do with all this storage space?

When the only storage devices available for your PC were single-sided 5¼-inch floppy disk drives, you used disk storage for programs and discrete data files. Optical technology enables you to view data storage in a new light. In conjunction with your computer, it offers far more than a dumping ground for data.

## Data into Information

Computer storage lets you sort, search, and manipulate information in ways that were never before possible. For example, in just minutes, a business executive can sort—and group by region—the total sales for his or her company for a decade; a doctor can retrieve a concise and diagramed summary of a particular ailment and information about treatment; and a programmer can trace every instance of a particular variable in an enormous program.

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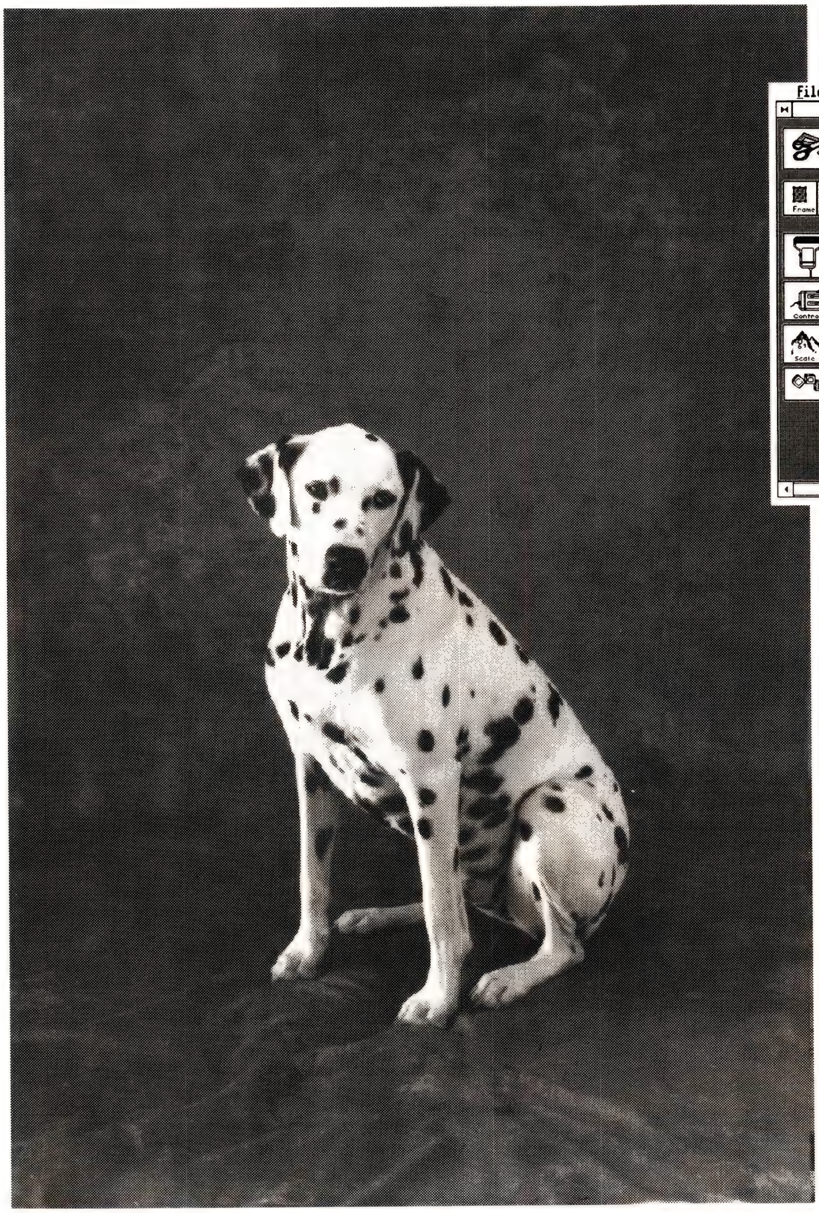

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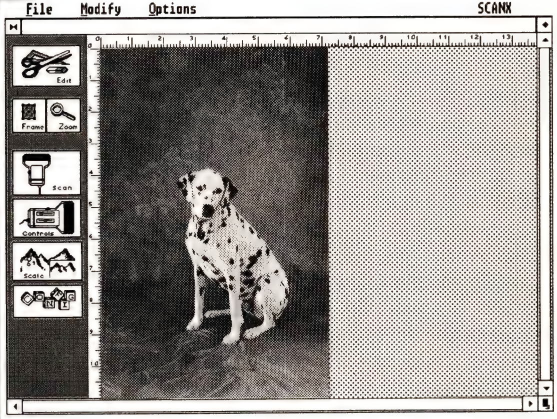

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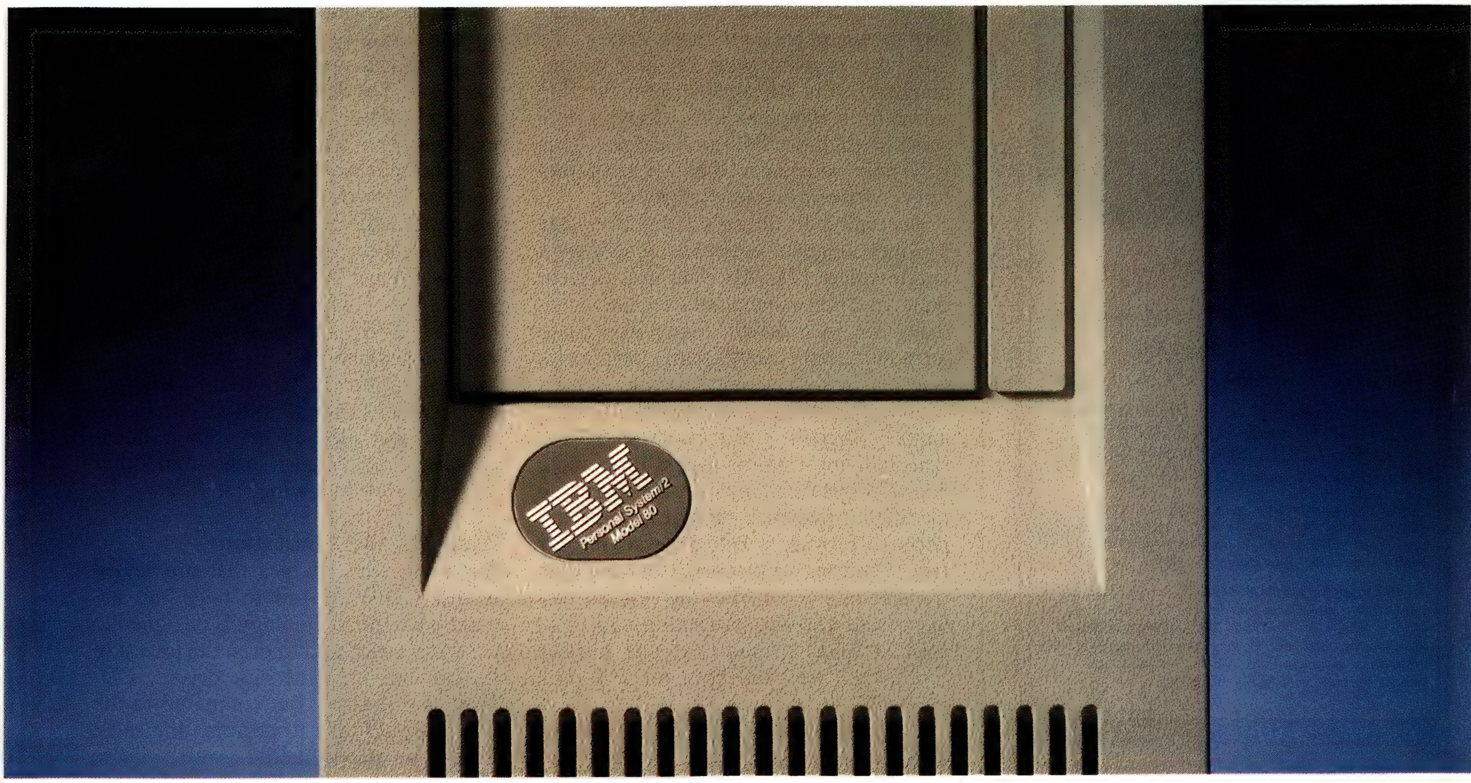

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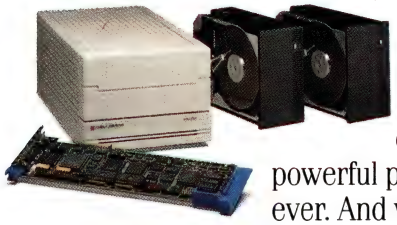

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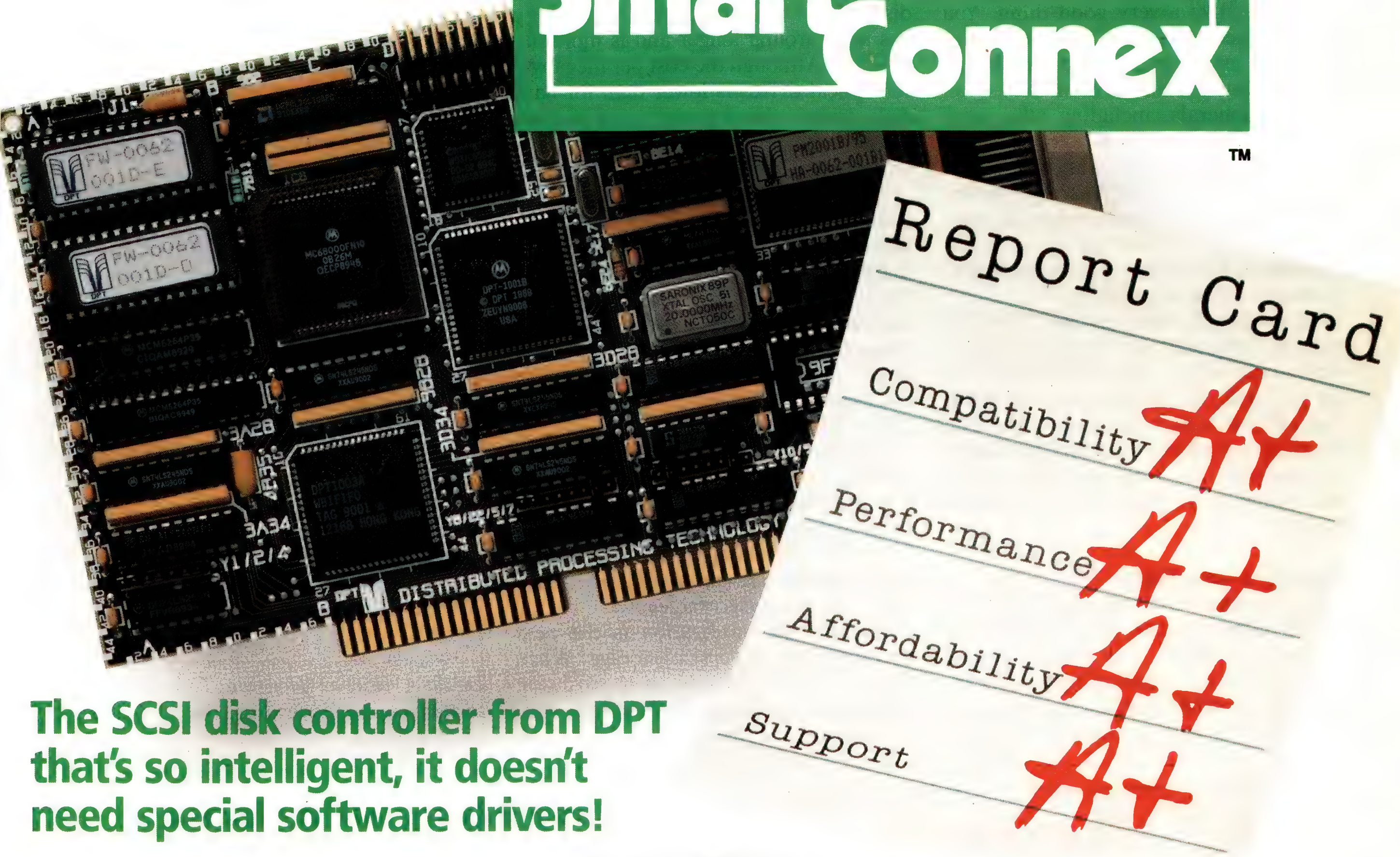

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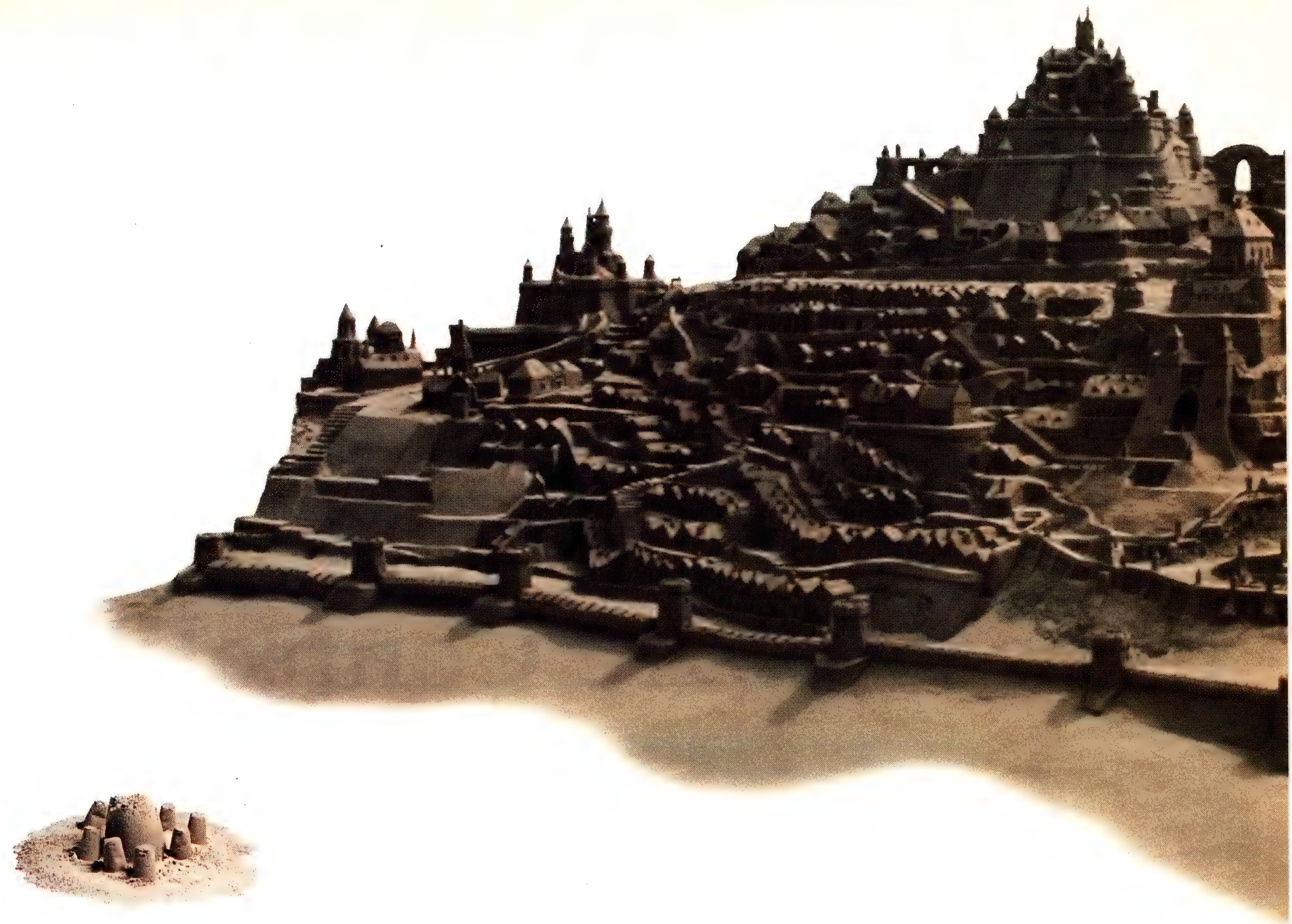

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# CONTINENTAL COMPUTING

*Despite IBM's success there, Europe is a diversified marketplace for computer companies foreign and national*

### *Colin Barker*

If I had to pick out the most important month in the history of personal computing in Europe, the choice would be easy: January 1983. That month I attended two press events and saw products that have completely reshaped the European personal computer market and decimated the indigenous U.K. microcomputer industry.

## The Beginnings

The first event was a "hands-on" demonstration of a new Apple computer. It was a secret meeting at Apple's European headquarters in Hemel Hempstead in England. After solemnly signing nondisclosure agreements, I sat down in front of a funny-looking computer called the Lisa and was amazed at what I saw. This was probably the easiest-to-use computer ever invented, shown in all its glory, albeit not in its final form—we had a year to wait for the Mac—and I left the demonstration convinced that I had seen the future of personal computing, and it was good.

Two weeks later, I pressed into a room with around 150 other U.K. computer journalists and waited with bated breath for the "big news" from IBM. It was the belated launch of the IBM PC in Europe, a full 18 months after its U.S. debut. What I saw was a basic, and not particularly well-designed, 8-bit computer dressed up in semi-16-bit clothes. It had a new operating system that looked a lot like CP/M, a keyboard that had important keys in the wrong places, a noisy fan, and slow and noisy disk drives. The monitor was poor: It was big and clunky, you couldn't tilt it, the poor phosphor quality hurt your eyes, and it had a weak character set. (For ergonomic reasons, it was not legal in Sweden and Germany.) The PC had nothing special to offer over existing systems. Compared to the stately elegance of the Lisa, it stank. But the price was a lot better.

At the time that these two systems were being launched, Europe had a thriving microcomputer industry. In fact, it had many different industries that all contributed to the "new technology" boom. The IBM PC and, to a lesser but still important extent, the Macintosh, changed all that. In the next four years, the U.S. computer industry would come to dominate the European microcomputer market. Why was this so?

## Europe Is Different

"One of the biggest mistakes you can make when you launch a European subsidiary is to assume there is some kind of United States of Europe," says Don Taylor, an American with considerable experience establishing European subsidiaries for U.S. computer companies. He is

*continued*

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home or hobbyist computers in the U.S., they were used by both small and large businesses in Europe.

But none of this stopped IBM. With a corporate steamroller approach, IBM launched a blanket marketing campaign and went after its traditional customer, the corporate data-processing manager. It took IBM longer to get the PC off the ground in Europe than it did in the U.S., but it succeeded.

The control that IBM holds over the market is not absolute, however, and there are some notable exceptions to it. And while the big names in the PC software, hardware, and networking business in the U.S.—Lotus, Ashton-Tate, Borland, AST, and Novell—are big in Europe as well, the market is *not* a reflection of that of the U.S. In Germany and Denmark, the Commodore Amiga is popular as a business system; the Germans like the Atari systems as well. If you thought that Digital Research's Concurrent DOS and GEM were "dead" packages, you'll be surprised to find that they sell well across Europe. Multiplan is the most popular spreadsheet in France, where they love the Macintosh. A PC database called DataEase outsells both dBASE III and IV in the U.K.

### Timing and Attitude

Two major factors that help determine if a company will succeed in a particular country are timing and attitude: the timing of the move to Europe and its attitude toward Europe.

The classic—and mistaken—way for a U.S. company to approach the European market is to set up a subsidiary in the U.K. or Ireland, launch products there, and (if successful) try to extrapolate the reasons for that success across Europe.

This is an understandable course of action, since it gives the company a chance to try to understand the European mentality, market, and culture while dealing in a common language. The problem is that the U.K. is atypical of Europe. Of all the European PC software and hardware markets, the U.K.'s is the closest to the U.S.'s. A "top 10" of PCs, software, and hardware would be more like the U.S.'s top 10 than any other market's in Europe.

Some companies began early with Europe and learned quickly. One such company is Digital Research. It opened its European offices in the U.K. in the days when CP/M was virtually the only microcomputer operating system available on more than one type of machine. It licensed the system to many local hardware suppliers, first in the U.K. and then all over Europe. While Microsoft was sweeping the boards in the U.S. after the launch of the PC, Digital Research plugged away first with CP/M-86 and then with Concurrent DOS and GEM. Microsoft arrived in Europe, via the U.K., soon after the PC was launched in the U.S. Microsoft did well, but Digital Research had done enough work to ensure that it had a future in Europe.

On the hardware side, it is a similar story. IBM cut a swathe through the suppliers of microcomputers, and now the IBM PC standard dominates—with some exceptions.

> *Two major factors that help determine if a company will succeed in a particular country are timing and attitude.*

### Of Apricots and Acorns

Before the PC arrived, the U.K. boasted more than 20 domestic manufacturers of microcomputers, all different, with different operating systems and no standards. Most have long since vanished. One supplier that held out longer than most is Apricot. This company came out of a systems house called ACT. ACT first became involved with microcomputers when it won the rights to sell the Sirius microcomputer in the U.K. From there it was a short step for the company to set up its own manufacturing arm to make the Apricot computer.

This was an interesting system: It was one of the first to use 3½-inch floppy disks as standard, which meant that although it was based on the 8086 processor and could run MS-DOS, it was not IBM PC-compatible. A neat design with an excellent screen made it a system that disparaged the IBM PC. It was semiportable—in the same way that the early Macintoshes were—and packed more power than an IBM XT into a very small box.

Its success was helped by the fact that many data-processing managers (the biggest PC customers) were familiar with the ACT. It was like buying from IBM; the Apricot came from a company people thought they could trust. But, like everybody else, Apricot had to fall into line, and, in recent years, the only personal computer products coming out of the company have been been PC compatibles. This year, ACT sold the Apricot portion of its business to Mitsubishi.

Acorn is the only other major personal computer supplier to survive the last six years in the U.K. This company produced an 8-bit computer that, thanks to generous government support, became the standard for use in British schools. It was also successful as a home computer. As times got tough in the home-computer marketplace, Acorn diversified into Unix systems. The company produced the excellent Archimedes computer for the home/educational market and the R100 series of Unix workstations based on its own RISC technology. This was not enough, though, and Acorn is now owned by Olivetti.

### Survivors

Look around Europe, and you'll see similar tales of manufacturers struggling to come to terms with IBM and either going out of business, finding a benefactor, or falling into line and producing PC compatibles. Olivetti has been the most conspicuously successful company.

With a solid background in office systems, Olivetti first moved into the PC market with the M24. This PC compatible was stylish, performed better than anything IBM offered (although tweaking the system gave it some compatibility problems), and was very well designed. It took up just over half the desk space that the IBM PC required, but it still had the same number of slots and a much better screen. In fact, Olivetti tried to repeat the success of Compaq by offering compatibles with added value and Italian élan. It was hugely successful in Europe; it was also Europe's last great shout in the PC market.

Over the last four years, the European market, like the U.S. market, has become a commodity market and is much more price-driven than before. Suppliers from Japan and Taiwan have moved in and have been very successful. But the European suppliers will not lie down; they still add variety and interest that you will not see anywhere else. Olivetti still produces the prettiest and most elegantly designed PCs. Victor of Sweden produces PCs with lots of power in a small box. Schneider of Germany produces PC compatibles that are to the PC industry

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# CREATING VIRTUAL PCs ON THE 386

*They said it could be done but never told how; here is how!*

Matt Trask

With the introduction of the Intel 386 microprocessor, it became possible to create virtual machines with a desktop personal computer. Although there has been a long tradition of VMs in larger computer systems, such as the Wang VS series and the IBM 360 with CP/CMS, this is the first time this kind of capability has been available to the small-computer user. OS/2 2.0, Alloy's 386/MultiWare, Microsoft Windows/386, and the Borland Turbo Debugger all use this new operating mode.

Even if you are not trying to create the next great hypervisor for MS-DOS, the emulation techniques discussed here will show you how to use the 386's virtual 8086 (V86) mode to virtualize an IBM PC compatible in your favorite 386 operating system.

Although the Intel literature makes the statement that "the 80386 can switch rapidly between its protected mode and V86 mode, giving it the ability to multiprogram 8086 programs," there is very little information available for the programmer on how to implement such a system. I will draw on my experiences with Phoenix's VP/ix and Control/386 projects, as well as the Stellar "MS-DOS in an X Window" project, to describe the various methods used in creating a virtual PC (VPC).

## A Historical Perspective

For the purpose of this discussion, I'll define a VM as any combination of hardware and/or software that creates an environment in which a piece of software can be fooled into believing that some hardware feature or operating-system capability exists when it really doesn't. A good example of this is the familiar RAM disk programs that are used on many PCs. This combination of RAM and software creates the illusion of a very fast disk drive that an application program cannot distinguish from the real thing.

VMs have traditionally been offered as a way of maintaining backward compatibility with an existing software base when a computer manufacturer introduces newer, incompatible hardware or operating systems. In this way, vendors can offer newer technologies while leaving their customers with that warm fuzzy feeling as they continue to use all that expensive software and data they accumulated with older systems. IBM's System 370 with VM/370 is a good example of this, because it can actually run OS/370 batch jobs faster in individual VMs than if the jobs are all multitasked under OS/370.

Although VMs may seem to be the sole province of large computer systems, the PC community also has a long

continued

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for more specialized uses, such as backfilling DOS memory to 640K bytes in machines that are capable of adding only 512K bytes below the 1-megabyte boundary. Debuggers such as Nu-Mega Technologies' Soft-Ice/386 and the Borland Turbo Debugger are among the more interesting applications that can be found in the control-program genre. These products operate on real-mode DOS applications and run them in 640K-byte VMs. By keeping their own code outside of the DOS address space and using the CPU's hardware debug registers, they can provide functionality similar to that of much more expensive in-circuit emulators.

My own Stellar MS-DOS project falls into the control-program category. Its primary function is to run a 386-based service processor built into the Stellar Model GS1000 Graphic Supercomputer. In this capacity, it boots the big CPU and handles low-speed I/O devices, such as mouse, keyboard, and serial lines, on behalf of the GS1000's native Stellix operating system. Because this places little demand on the 386 CPU, all extra cycles are used to run MS-DOS in a VM that displays its output through the Stellix X Window System display manager as if it were a native Stellix application.

### How to Virtualize

Emulation is the technique of gaining control of the CPU from a program that is executing and passing the program's execution to some sort of a monitor or supervisor program. This monitor then determines what the original program was trying to do, causes the desired result, and restarts the original program at the place at which it would have normally arrived if it was not in an emulated environment. This taking of control is referred to as *trapping* and usually requires hardware support. On the 386, trapping generally takes the form of a general protection (GP) interrupt. An example of software-based trapping would be a virtual disk device driver that is chained onto the Int 13h vector so that it gets control every time a disk request is made.

The 386's V86 mode provides many trapping mechanisms you can use to support emulation of PC-compatible hardware. It is possible for a VM monitor (VMM) to set up trapping on accesses to I/O ports, interrupts, operations that affect the interrupt flag (IF), and attempts to execute privileged operating-system instructions, such as those that enter and leave protected mode.

The figure describes the flow of control in a keyboard emulation. PC-based application programs typically get keystrokes by using Int 16h to read them from a ring buffer. The data objects in the ring buffer are a combination of an ASCII value and the scancode of the key that was pressed. In the Stellar MS-DOS implementation, all keystrokes are received from an X window and must be translated into a form that is useful to PC applications. If a trap is taken every time an Int 16h is issued, the VMM can read an X keyboard event, translate it into an ASCII/scancode pair, load this value into the AX register, and resume execution at the instruction following the Int 16h.

## Address Translation

The 8086 and 8088 CPUs generate linear memory addresses from two components—a segment and an offset. The segment address is shifted left by 4 bits, and the offset is added to the result, giving a 20-bit linear address. A 286 or 386 in real mode generates addresses in the same fashion.

The segment component is renamed to selector when running in protected mode. Instead of being a value that can be used directly to compute an address, a selector is an index into a table of segment descriptors. Each descriptor contains information about the location, size, and protection attributes of an area of memory. When a selector is loaded into one of the segment registers, its associated descriptor is used to calculate linear memory addresses instead of the older shift-and-add method.

When the 386 CPU is run in virtual 8086 mode, address translation is done as if it were an 8086 CPU. This means that all virtual PC address space must begin at an offset address of zero. Protection in a multitasking system must be provided by the memory management unit because segment descriptors are not used.

Other examples of emulation are the so-called limulators—products that provide the same functionality as an Intel AboveBoard by trapping all use of Int 67h and using the 386's page-translation hardware to remap extended memory in the same way that the AboveBoard's hardware remaps extended memory.

### Why Virtualize?

By supporting VMs, an operating system can execute other operating systems as if they were applications, or perhaps just execute applications that would normally run under some other operating system. An example of the latter would be a version of Unix that has been extended to directly execute OS/2 binary programs.

One primary reason for virtualizing an operating environment is to provide the illusion of hardware support for peripheral devices that do not really exist. Often the host system will have peripheral devices such as floppy disk drive controllers or video controllers that are not compatible with the NEC 765 and Motorola 6845 used in the PC; in this case, the emulation software can translate I/O requests into a format that is meaningful to the native devices. An equally important reason for virtualizing an operating environment is to provide for the sharing of devices like serial lines and floppy disk drives in multitasking environments.

Although it is possible to create an environment that directly virtualizes MS-DOS by trapping at Int 21h and virtualizing the individual DOS calls, I believe that a more thorough and compatible job can be done by emulating the hardware of the PC itself. In the past, operating systems like Concurrent DOS (also known as Concurrent CP/M) provided less-than-complete emulations via the use of filter programs and case-by-case exception handling to run only the most popular applications software.

### 386 Support for VMs

The 386 has many advanced features that support the creation of VPCs. These include multitasking, virtual memory, memory protection, and I/O protection. The 386 multitasking model provides for hardware-based task switches in which the registers associated with an outgoing task are dumped by the CPU into an area of memory called a task state segment, and the registers for the incoming task are restored from its TSS. V86 mode is a special kind of task—when bit 17 of the EFLAGS register is set, address translation for the associated task is done as it would be on an 8088 (see the text box "Address Translation" above). There are also changes to the way that I/O protection is handled that make it easier to do device emulations.

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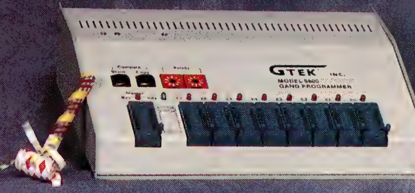

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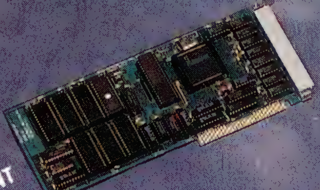

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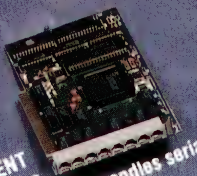

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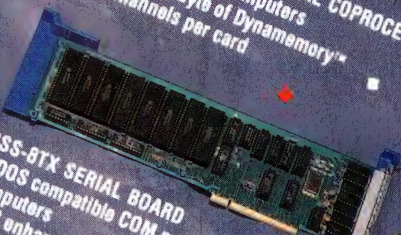

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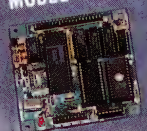

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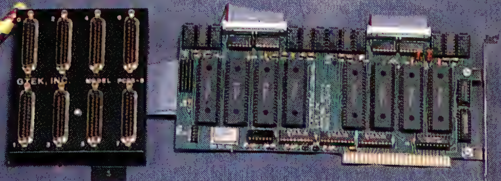

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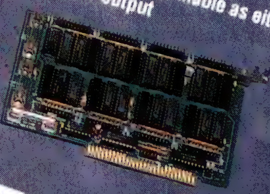

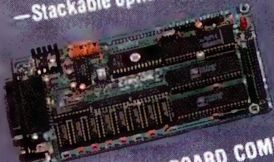

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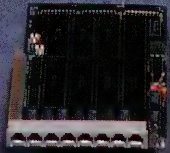

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trap on the video BIOS alone would be inadequate to emulate all 1-2-3 output. The consensus among many 386 VM developers is that EGA graphics emulation is too difficult to perform in software. The complex architecture, combined with many write-only control registers, would consume too much compute power in return for a very-low-performance emulation. VGA, on the other hand, may provide new opportunities, because a simple hardware assist can intercept the video data at the auxiliary video connector after the VGA has done all the hard work but while the output data is still in a digital form.

### Emulating Disks and Drives

Floppy disk emulation is a challenge because of the secretive nature of the copy-protection industry. You can emulate normal disk operations, such as sector reads or writes, by trapping Int 13h and reading from or writing to a 360K-byte file containing the image of a disk. This facilitates device sharing by allowing each user to have his or her own floppy disk image.

When dealing with copy-protected applications, it is usually easiest to disable trapping in the VPC I/O permission bit map so that direct access to the floppy disk drive controller chip is possible. Of course, this will work only if an NEC 765 or compatible FDC chip exists in the system at addresses 3f0h through 3f7h. The real floppy disk drive can be shared among multiple VPC users when you implement a trap on the first access algorithm; this releases I/O trapping when a VPC first attempts use, and reenables trapping when the application has completed its use of the floppy disk drive.

Hard disk drive emulation is similar to floppy disk drive emulation with one notable exception—it would not be desirable to keep a 30-MB emulation file hanging around waiting to be filled just because a type-3 drive is being emulated. The VP/ix emulation uses a minimal-size file that is extended as needed when files are written to it. This is most useful for booting MS-DOS and for programs that can install their copy protection on a hard disk.

A better way to emulate large mass storage devices is a file redirector that translates requests (e.g., open, close, read, write, and find first) into requests for the native file system on the host operating system. Stellar MS-DOS uses this method because it has the additional benefit of allowing DOS and Stellix files to be shared transparently from either environment.

### Clocks and Interrupts

The battery-backed real-time clock chip (also known as the CMOS) must also be emulated, because it provides information to the VM about memory size and device configuration. It would be inappropriate to allow direct access to the real CMOS (if any), because it is used to boot the host operating system and must be protected from capricious changes. A 64-byte data file containing the image of a CMOS can be maintained for each VPC, allowing all users to have their own configuration and concept of time and date.

> *One interesting fact about the MS-DOS operating system is that it does not need a real clock in order to function correctly.*

Many PC applications make direct accesses to the 8254 counter/timer chip in order to generate unusal sounds, measure real-time events, or provide a periodic timer tick interrupt at a higher rate than the PC-standard 18.2 Hz. A state-machine timer emulation needs to receive periodic signals from the host operating system to keep track of the passage of time. An interesting fact about the MS-DOS operating system is that it does not need a real clock in order to function correctly. One way to take advantage of this and improve VPC performance might be to give just one or two timer signals per second to the VMM and adjust the tick count in the VPC's low memory every 15 seconds or so to the correct value. This would allow time to pass for file-system time stamps and applications, such as the Brief editor, that have on-screen clock displays.

An emulation of the 8259 programmable interrupt controller (PIC) chip plays a role in many of the other emulations. Before acting on a queued interrupt signal for a timer tick or an incoming serial line character, the VMM must examine the state of the PIC emulation to determine whether this interrupt level is enabled and not masked. Similarly, the state of the virtual IF in the VPC's FLAGS register must be checked to ensure that an application has not issued the CLI instruction to disable external interrupts.

### Other Devices

Sound emulation can be a particular challenge because of the diverse uses placed on this seemingly unimportant subsystem. You can emulate the standard beep tone that is generated by the ASCII BEL character (^G) on just about anything, even on a serial terminal console device, but you can emulate the more complex sounds that are used with game programs only if there is adequate hardware support.

You can support serial communications using the example I gave earlier for emulation techniques. One copy of the UART structure would be required for each emulated port. This is a place where the VMM must use interrupt queuing and signals, because incoming data and UART status might be lost if the VPC task is not running when the real hardware interrupt occurs.

Sharing a printer is not a problem that most PC applications are concerned with, since each PC usually has its own. But in a multiuser system or a system in which a 386-based VPC is hosted under an operating system like Unix, printer control is managed by a spooler program rather than directly. The VPC can trap BIOS outputs that use Int 17h. When the VPC receives the interrupt message, it can direct the outgoing characters to a disk file. When the print job is done, the VPC can then send the file to the print spooler. Spooling is a major problem in the PC environment because there is no real concept of job end or end of file when printing. There are three strategies that the VMM can use to detect this condition and submit a print job: time-out, program termination, and direct user interaction. A time-out would close the file and send it to the spooler after some duration since the last character output. The VMM would detect the termination of a program by a trap on Int 20h and the DOS Int 21h subfunctions 00h, 31h, and 4ch. Direct user interaction is the simplest and least elegant method—the user would have to run a short program or make a selection from a system menu with a mouse to start the printing job.

Mouse emulation is the one type of emulation where the least amount of slop can be tolerated—since the mouse is a high-performance component of many

*continued*

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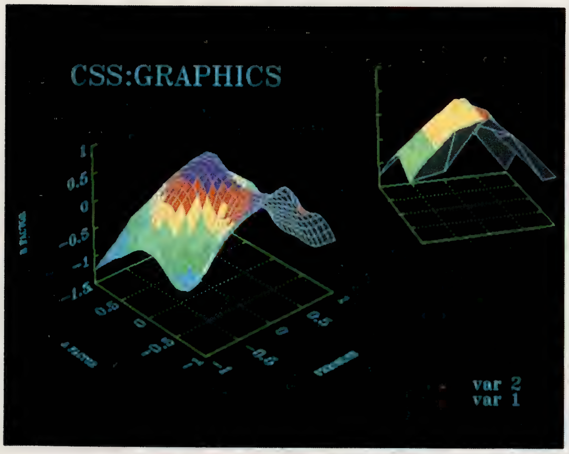

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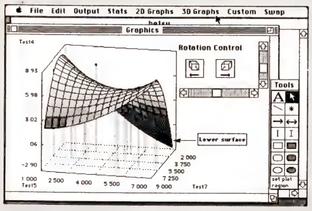

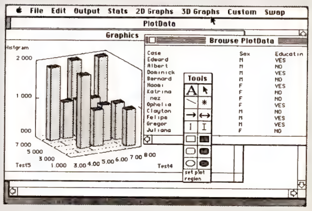

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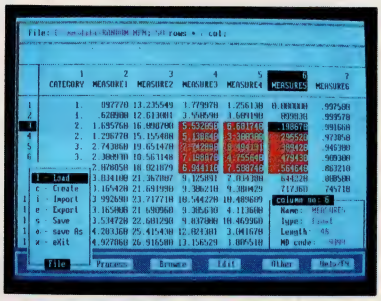

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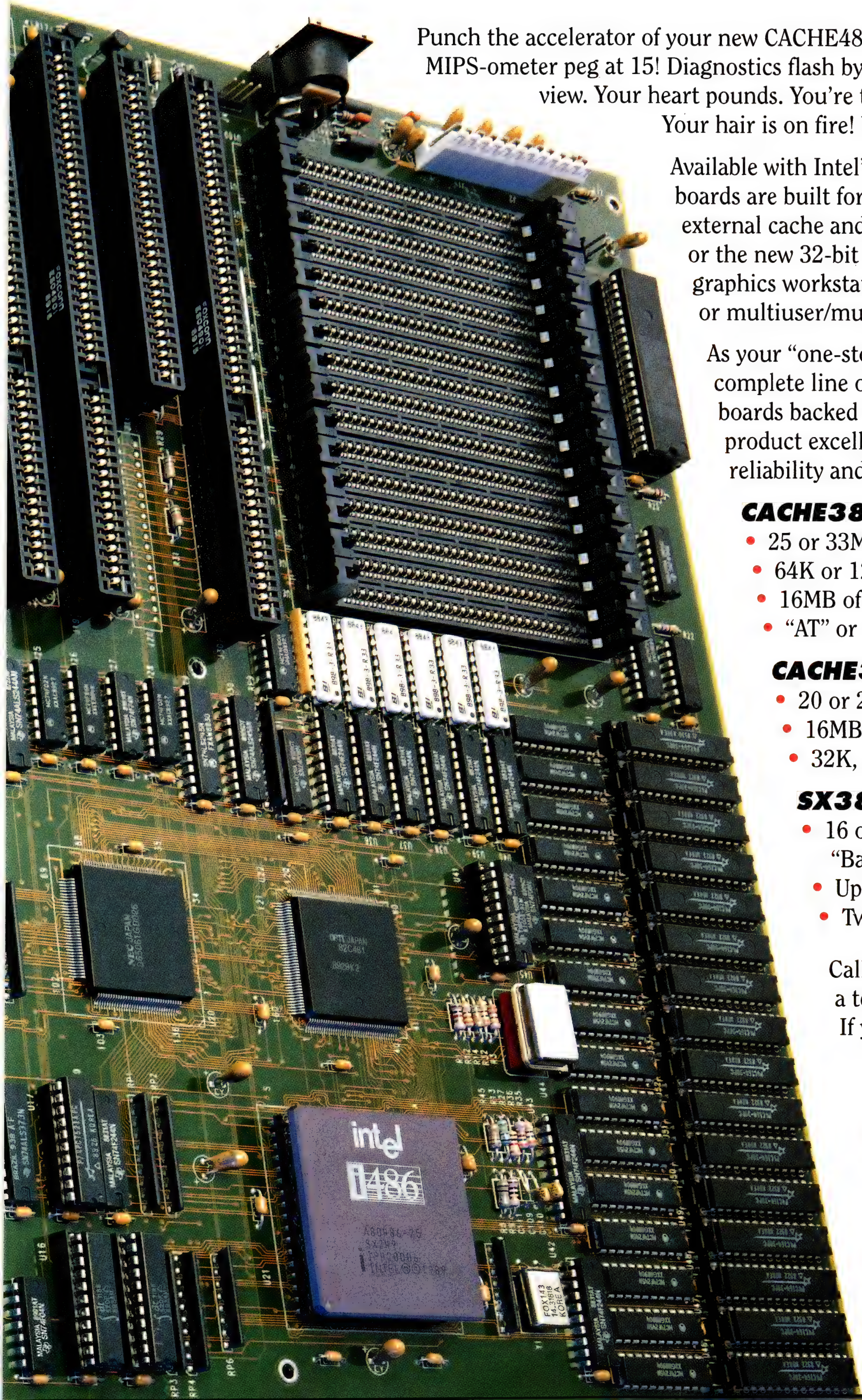

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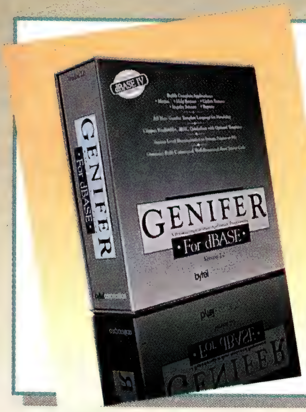

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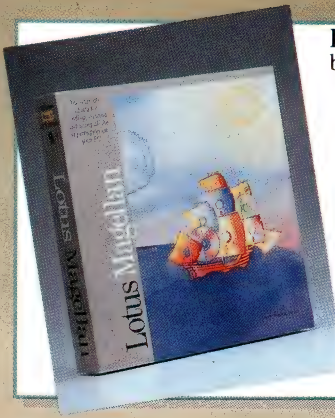

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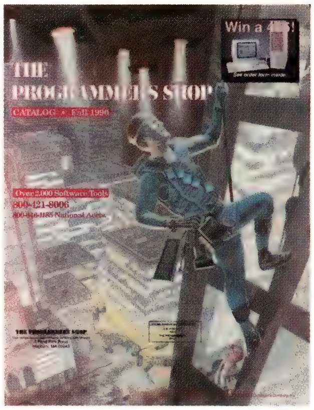

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# NOTEBOOK PCs SET THE PORTABLE STANDARD

*Today's state-of-the-art totable computers pack AT-class power into about 6 pounds*

*Paul Schmidt*

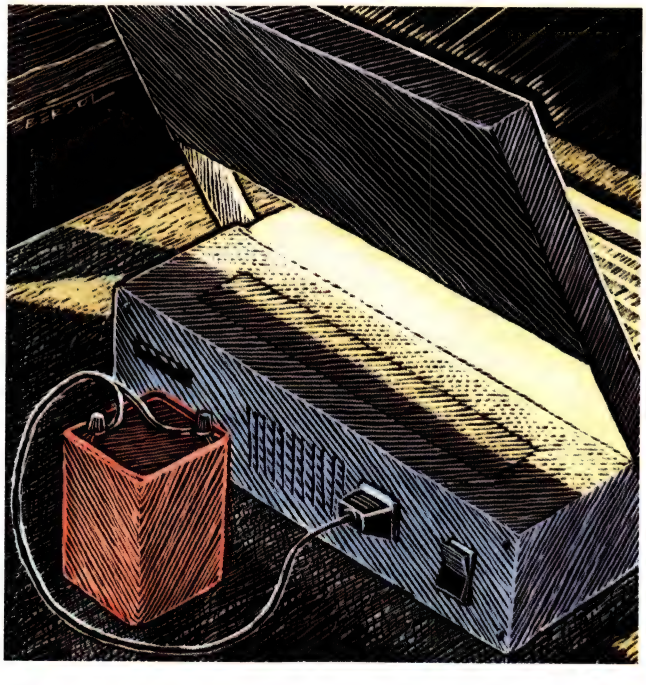
The portable computer market is an exciting, dynamic arena. It seems that every new model introduction advances the state of the art. Portables are receiving more development attention as sales increase; they are becoming a very important segment of the PC market. According to International Data Corp., about 9 percent of PC sales in 1987 were portables; by 1992 that market segment should jump to 15 percent.

But what defines the state of the art in portable technology? What sets a portable ahead of all the others in its price bracket? The factors that are most often evaluated are form factor (i.e., its physical design and dimensions), weight, screen quality, and battery life.

I will focus on a class of portables known as notebook PCs. These represent the fastest growing segment of the portable computing market. They range in size from about 8 by 11 by 1½ inches to 10 by 12 by 2 inches, and weigh 4½ to 8 pounds. Notebook PCs pack most of the utility of an AT-class desktop into the smallest possible package. Although seemingly a narrow niche, notebook PCs offer a lot of variety in terms of power (9-MHz 8088 to 12.5-MHz 286 CPUs), features, and price ($1800 to $5000). The photo shows some popular notebook models.

Other classes of portable PCs include hand-helds, laptops, and luggables. No "official" classifications of portable PCs exist; I use these terms for the benefit of this article. Hand-held PCs are battery-powered, weigh about 1 pound, and can fit in a coat pocket. The best examples of this genre are the Poqet PC and the Atari Portfolio.

Laptops are either battery- or AC-powered. They weigh between 8 and 17 pounds, almost always use more powerful 386SX or DX CPUs, and measure up to 15 by 16 by 4 inches. The Compaq SLT and the Toshiba T5100 are popular laptops.



Luggables are sometimes referred to as "lunchbox" PCs because of their shape, but not all luggables have that form factor. All luggables are AC-powered and provide the greatest performance in terms of CPU (386 or i486), mass storage, RAM, and video. The heaviest units (some of which have color LCDs) weigh up to 27 pounds—more than some desktop PCs. The Dolch-P.A.C. 486-25 and the IBM Model P70 are examples of luggables.

## Notebook Limitations

The screen and keyboard are the limiting variables in the design of notebook PCs. The current state of the art in keyboards is an 84-key design, with a numeric keypad embedded in the alphanumeric

*continued*

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*Three popular notebook PCs (from left to right): The Zenith MinisPort, the Compaq LTE, and the NEC UltraLite. The MinisPort and LTE weigh in at over 6 pounds each, while the UltraLite weighs only 4½ pounds.*

inches of glass, and any single failure ruins the display.

**Power Management**

By carefully selecting a display, an engineer can design a computer that is pleasing to use yet operates for a reasonable period of time on battery power. But simply choosing the right low-power components is not enough for a state-of-the-art laptop. Today's machines also manage power on the fly by selectively turning off unneeded portions of the machine.

Because the LCD and its backlighting consume large amounts of power, these components have been targets for dynamic power management. The idea is to shut down the display and backlighting whenever you aren't using them. The most convenient way to do this is to let the computer control the power automatically.

Special logic circuits can monitor the CPU address lines and capture memory accesses to the screen. When custom hardware is not available, the BIOS or a TSR-like program can monitor the display interrupt service routine. Because many applications bypass the BIOS and write directly to the screen, the software also monitors the keyboard hardware interrupt routine. Regardless of the method used, if the monitor does not see any activity within a given time period, it turns off the display subsystem. Any subsequent keystroke or screen write restores power.

The latest hard disk drives have 2-inch platters, hold 20 megabytes of data (40 MB by the end of the year), and easily fit into a shirt pocket. The size of the drive is obviously important with small computers, but careful power management is crucial for battery operation.

Unlike displays, hard disk drives never operate on a constant basis; an application is loaded and a data file is read in, but after that, almost all processing takes place in memory. There may be some occasional disk activity, but the disk is not needed again until you want to update a file. If the drive is off when you don't need it, you can save a significant amount of power.

While you can monitor and control drive activity with software, several hard disk drives now have specialized power management electronics. These drives use programmable internal timers to decide when to drop back to a low-power state. When a drive switches into this mode, it removes power from portions of the drive electronics and, optionally, the spindle motor. When the CPU attempts to access the disk, it must be held off for a short time (at worst, only a few seconds) while the drive returns to an active state.

The PrairieTek hard disk drive is a good example. It has three operating modes: active, power save, and standby. In the power-save state, it powers down some electronic components. In standby, it turns off the spindle motor. The BIOS boot code programs the drive to automatically switch between states by setting timers in the drive to the desired values. After this initial programming, no further CPU intervention is required.

This can achieve considerable battery savings; when the drive is active, it draws from 1.2 to 3.5 W of power (the latter during platter spin-up). In the power-save state, the drive draws 0.9 W; in the standby state (motor stopped), it draws a mere 0.06 W. This power savings barely affects performance: It takes only 3 seconds to spin up the platter from standby to active, and only 100 milliseconds to get from power save to active.

With the increasing efficiency of hard disk drives and display panels, the power drain from the notebook's electronic components becomes an increasingly significant fraction of overall power consumption. One design goal to limit this consumption is to reduce the number of ICs required.

The most effective way to cut the chip count is to use a special set of IC chips that replace the functions formerly provided by numerous discrete logic components. Several manufacturers have various chip sets that have reduced costs in PC-compatible desktops. Other forms of integration, such as application-specific ICs, and surface-mount technologies also help reduce size and power requirements.

Because the amount of power that the computer's electronics consumes is proportional to the rate of logic switching, slowing the clock speed brings corresponding power savings. Virtually all chip sets provide programmable system-clock dividing circuits, allowing the CPU to slow itself down. The trick is to decide when to slow down the clock. If an application is simply waiting for keyboard input, then the CPU can slow down drastically (or even stop) with no discernible impact on performance. Unfortunately, current techniques cannot detect the difference between a genuinely idle condition and a complex spreadsheet recalculation; in the latter case, both the screen and the hard disk drive are inactive for a time even though the CPU is working furiously. Despite this deficiency, CPU speed management is a popular feature of notebook PCs.

Several new chip sets have been introduced recently (e.g., Genesis and 82340 from Intel, and LEAP from Chips & Technologies). In addition to saving on power and chip count, they monitor and control various system activities (e.g., video access) in hardware.

Suspend/resume features are also a type of power management. This utility preserves the state of the system and then

*continued*

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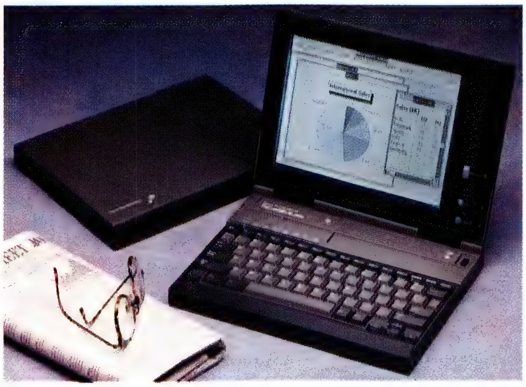

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# LOOKING AT THE GRAPHICAL USER INTERFACE

*Graphics capability is reaching a critical mass stage, with a number of high-quality choices*

*Bill Nicholls*

Graphics, like the year of the LAN, will sneak up on us. In the next few years, most larger systems will use a graphical user interface. By then, the rationale for a GUI will be obvious, yet today the GUI is a hotly debated issue, and the outlook for its success is far from certain. To understand why I think this will change requires a look into the components of the GUI, especially the enabling graphics technology.

The question of graphics is broad, spanning a range of issues from the user who is the object of the graphics to the technology used to deliver the graphics. The various components are the display, the controller, the software environment, the application, and the user—two hardware, two software, and one jellyware.

Hardware has been the primary constraint on the broad availability of graphics, since the other components have been available for varying lengths of time and with varying degrees of capability. Recent developments in all the component areas have made the success of graphics, and of the GUI, almost inevitable.

## Hardware

Starting with display technology, we can see two tracks: the traditional CRT and the newer flat-panel (FP) technology. The CRT represents a mature technology that is being pulled by consumer demand and pushed by its competition to lower prices and raise performance.

The once-expensive EGA display has been replaced by VGA-capable displays that cost less than a CGA display I got in 1984. Super VGA (800 by 600 pixels) displays are an incremental cost increase over VGA, and displays supporting 1024-by 768-pixel resolution are now under $1000 at mail-order prices. We can expect higher-resolution displays to follow VGA down the cost curve.

FP technology is currently on the warm-up track, replacing the CRT where the FP advantages in size, power, and ruggedness outweigh its cost and performance disadvantages. With the exception of units like IBM's large plasma display, FP displays do not replace the CRT. Rather, they supplement the CRT and are usually sold as an integral part of a portable system.

Because FP technology is just beginning to mature and CRTs are near the peak of their maturity, I expect the penetration of FP displays to begin to increase. FP technology will probably show up first in mass-market TV sets and will later displace CRT units in the computer environment.

Graphics display controllers are on the fast track. From the basic Hercules chip to the VGA "Tower of Babel"

*continued*

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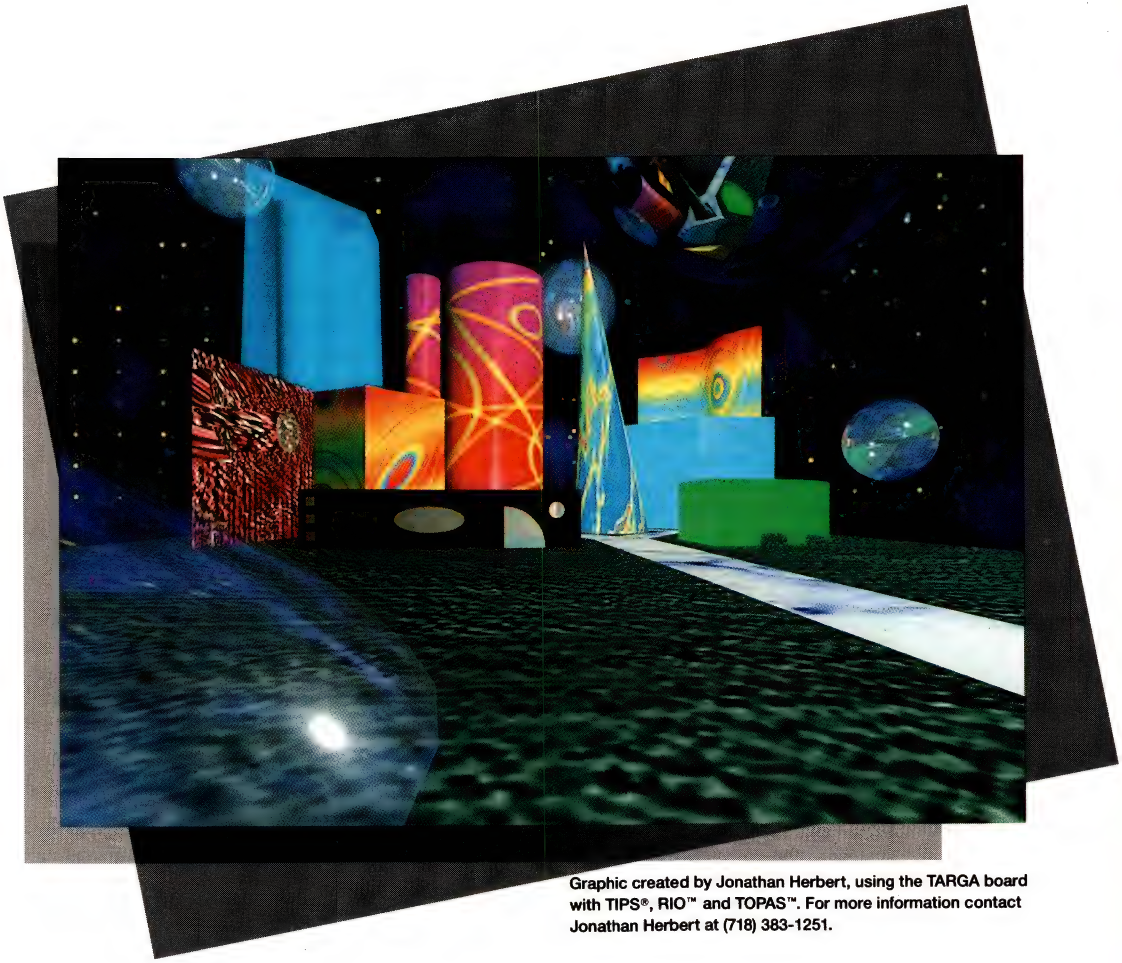

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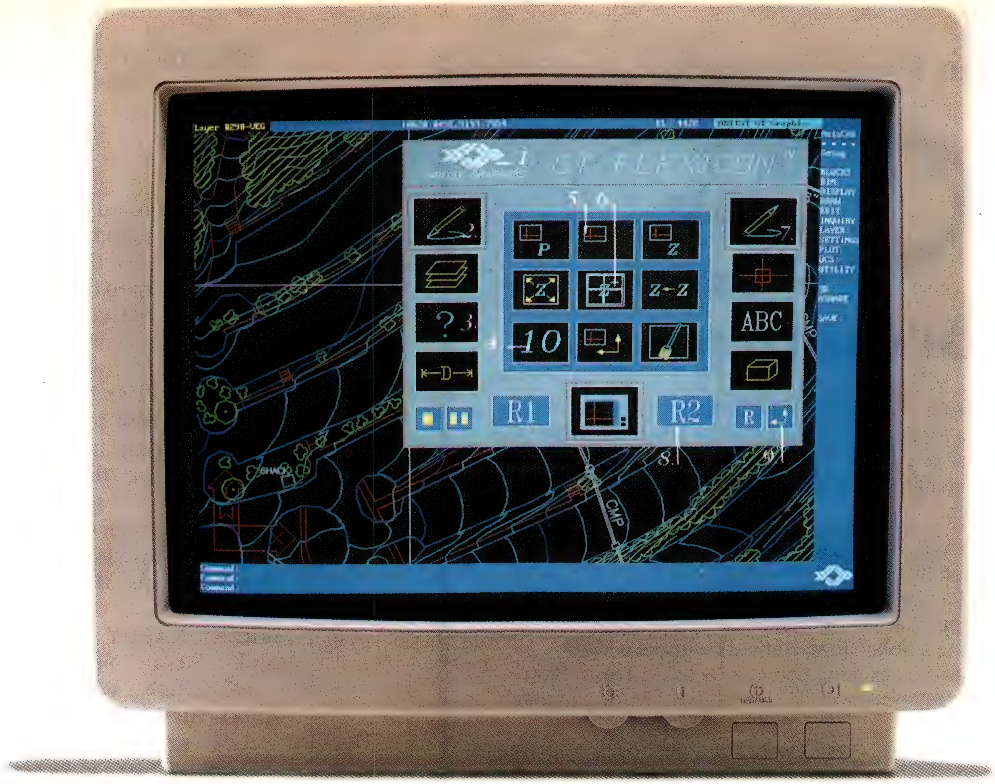

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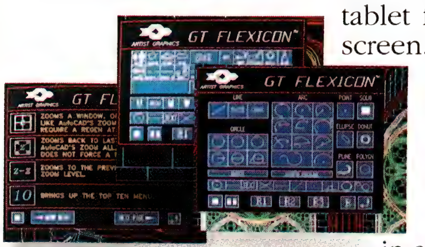

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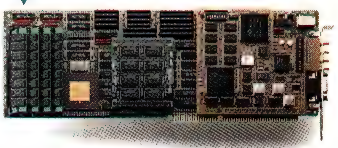

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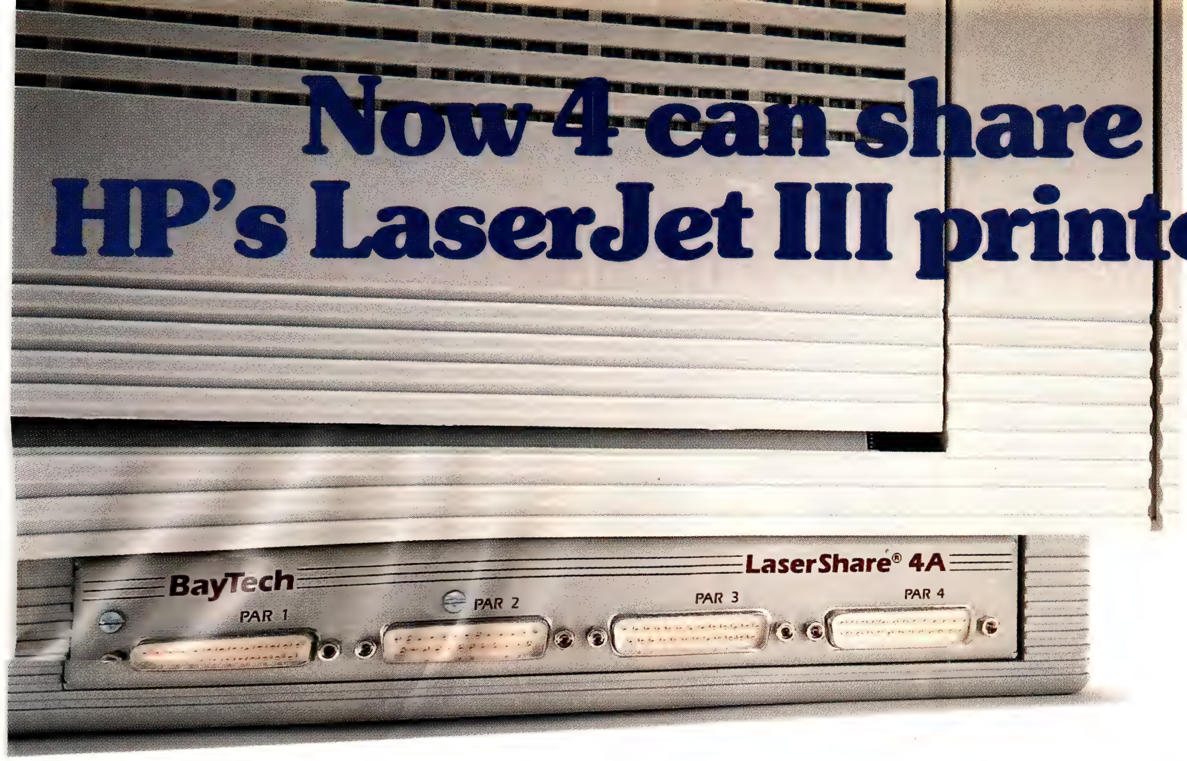

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# LAYING OUT THE FUTURE

*Increased capabilities and color should give desktop publishing a rosy future*

*Matt and Mary Page*

Our perspective on the future of desktop publishing is that of a small business, specifically an advertising agency. Our capital expenditures for computer equipment have to be carefully researched, as the difference between a good and a bad buying decision can ultimately mean the difference between staying in business as a profitable entity and struggling month to month. Discussing some current issues facing DTP is a good starting point for leading into what the future holds for DTP.

## First, Some Background

Back in November 1987, we started Page After Page, a small, full-service advertising agency in Rutland, Vermont. Most of our business comes from small- to medium-size companies. DTP can be lucrative; we've doubled our sales each year and added two more people to our staff.

We help our clients plan their marketing and advertising strategies, as well as design, develop, and produce everything from print ads, brochures, newsletters, and corporate identity programs to radio and TV spots and books. Recently, designing and writing software documentation has become a major portion of our business. An important production tool in the daily operations is DTP, and it has surely added to our company's success.

## Hardware/Software

We have grown up with and currently use IBM PC compatibles, as well as two Macs. Table 1 has a list of the equipment we're using. It's a mix of the new and the old—a mix that we think is typical of small DTP services.

But times are changing, and we'd like to keep current. As money and the business permit, we're planning strategic upgrades to enhance the performance of the software we have and to add new capabilities. Color figures heavily into the upgrade equation, as do beefier processors and higher display resolution. Table 2 shows our planned upgrades and our wish list.

## Eek! A Mouse!

The transition from keyboard to mouse was the first hurdle to get over when we started with DTP. The nature of our business compelled us to investigate the Mac because of its command of the graphics environment.

With the type of work we do, keeping current in both environments is essential for serving our customers and keeping a competitive edge. The ability to exchange disks with our clients has been an important asset. And the fact that most businesses use IBM PCs or compatibles ensures that we will maintain and, hopefully, progress with DTP trends on both platforms.

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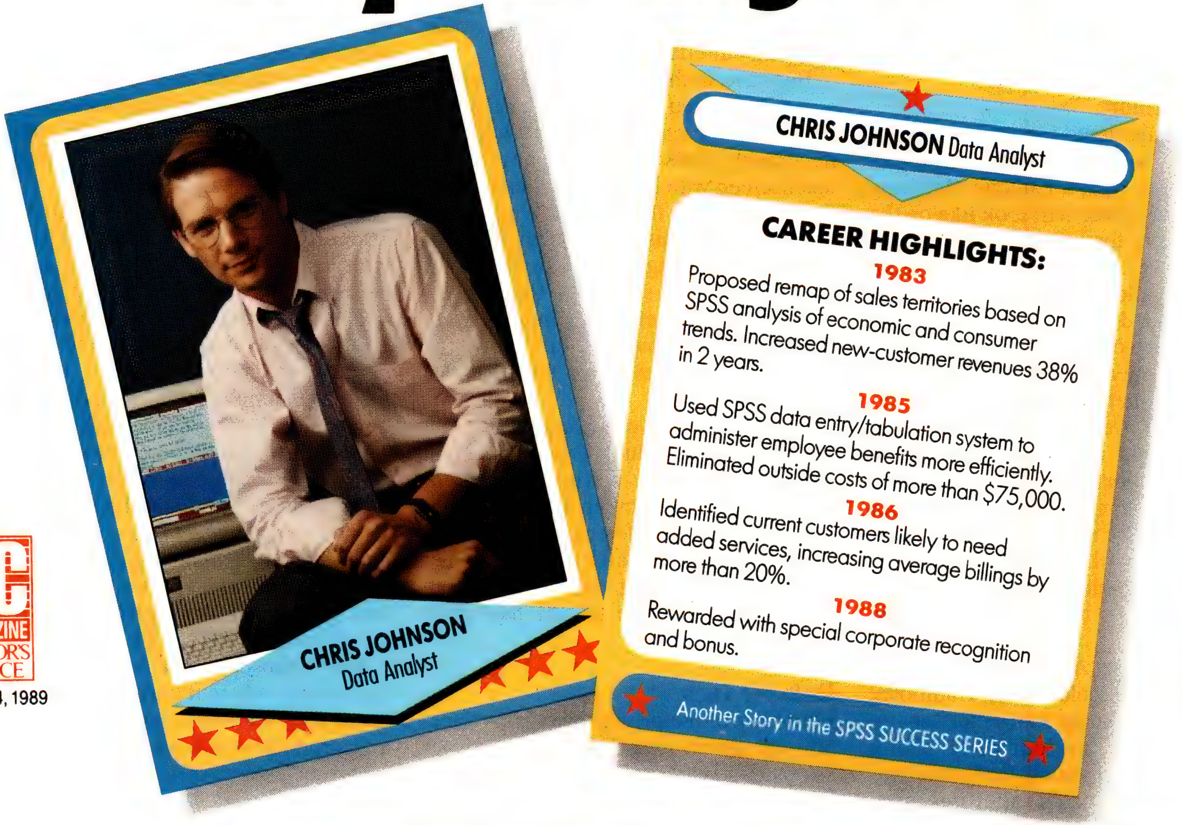

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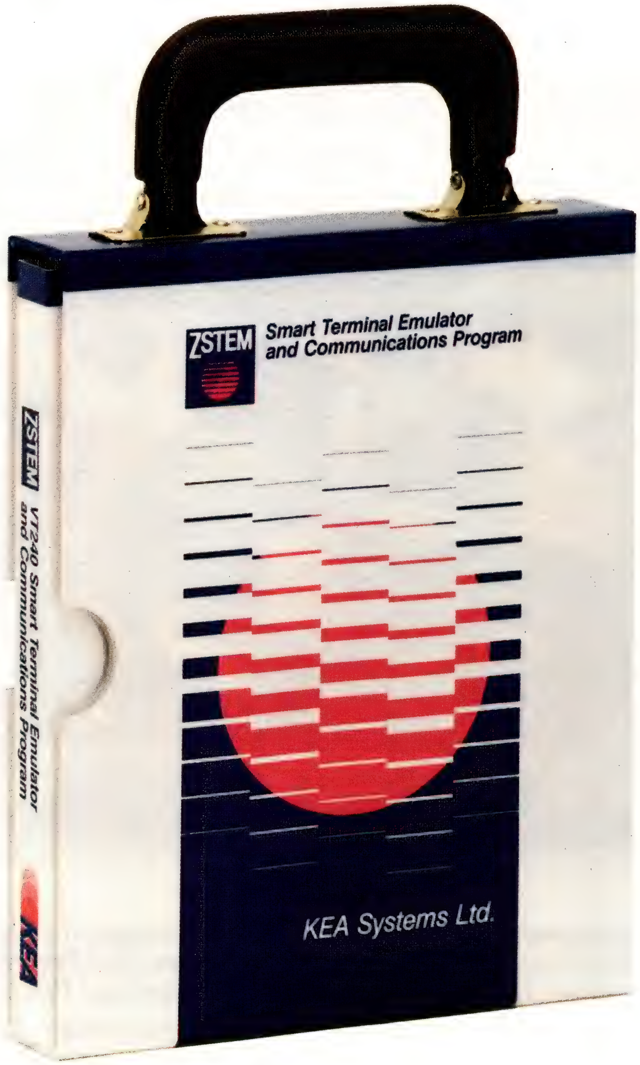
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# COLOR FOR THE DESKTOP

*New printer technologies offer color at a price*

Rick Cook

The average color printer is about four times as complicated as a monochrome printer with the same resolution. Color brings with it a whole raft of difficulties that you don't have in designing a monochrome printer.

Because of the problems and added costs, color printers are not likely to sprout up on everyone's desk in the next few years. They are getting less expensive and more flexible, however, and new computers and new kinds of software are making them more attractive all the time. A color printer also increases the scope of a computer system, so some users are willing to pay extra for them. Thus, color printers for desktop systems represent a fast-growing segment of the printer market.

There are three major technologies used to build color printers for desktops: dot matrix, ink jet, and thermal wax. A fourth technology, dye sublimation, is beginning to show up in small computer applications, and several other methods, such as color laser and dye transfer, will probably appear during the next two or three years.

## The Challenge of Color

The basic problem with color printers grows out of the way they print color. All existing color printers build up reflective colors by applying primary-color inks to the paper. In printing, those colors are cyan (blue-green), magenta, and yellow. All other colors can be blended from them. Since it is hard to get a good, solid black by mixing colors, almost all printers include black as a fourth color. This is called the CMYK system, K being the printers' designation for black.

The mechanical problems that this blending causes are obvious. The printer has to have four print heads or make four passes to lay down all the primary colors. To get the colors in the right place, the paper alignment with the print head, or *registration*, has to be tightly controlled. This is particularly true of page printers that use thermal wax or sublimation processes, in which the sheet of paper is run through the mechanism four times.

Beyond mechanical considerations, however, there is a whole other class of problems that grows out of the nature of color itself. For example, one-color printers are judged almost entirely on resolution. Resolution is important in color printers, too, but it doesn't tell the whole story. A sublimation printer at 160 dots per inch has a much better apparent resolution than a 300-dpi thermal wax printer, because a thermal wax printer produces visible dots and a sublimation printer doesn't.

On a one-color printer, black is black, pretty much. Gray scales are also pretty

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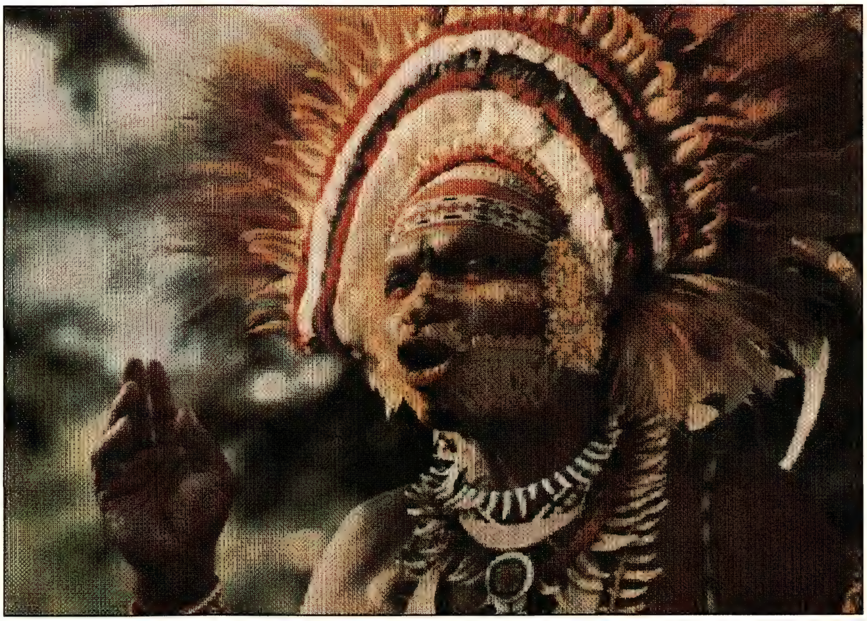

**Figure 1:** *An image created on an HP PaintJet XL ink-jet printer. Resolution is 180 dpi, and the original shows a lack of sharpness in areas such as the feather edges. Hewlett-Packard and others are developing 300-dpi ink-jet printers.*

and because of the size of the print-head wires.

Given multirow print heads, it is possible to lay down dots on 1/300-inch centers, but this isn't the same as having true 300-dpi printing. The other limiting factor is the diameter of the wires in the print head. Thinner print-head wires are more delicate and can't take the pounding of the solenoid hammer. Also, it gets harder to keep the wires from binding in the head as the mechanism heats up in use. For these reasons, the printing elements tend to be larger than the nominal resolution of the printer in high-resolution units. The printer may produce 300 dpi, but the dots overlap, and the image doesn't look as sharp as a true 300-dpi image.

Colors on a dot-matrix printer tend to be muddy. This is partly because of the inks used, and partly because the ribbon tends to become contaminated by other colors as it makes multiple passes across the paper.

The other problem is that, while dot-matrix printers can do color, they lack the specialized features built into other kinds of color printers. For example, dot-matrix printers usually do not have the processing power needed to support elaborate dithering algorithms. It is hard to avoid banding, moiré patterns, and other artifacts, especially in large areas of color. Photographic and other continuous-tone images suffer particularly.

## Ink-Jet Printers

An ink-jet printer can be thought of as a dot-matrix printer without the wires. Instead of using hammers to press wires through an inked ribbon, ink-jet printers spray drops of color onto the page. At low resolution, the result looks like dot-matrix printing. However, ink-jet printers are capable of higher resolution than dot-matrix printers. They also avoid some of the problems of dot-matrix color printers, at the expense of adding some problems of their own.

Some color ink-jet printers use solid ink (melted before spraying onto the paper); others use solvent-based ink. But most ink-jet desktop printers use water-based ink.

There are three main types of ink-jet printers, classified by the way they generate the droplets of ink. Some large ink-jet printers (but no desktop models) use a pressurized ink feed combined with fast-acting valves to produce ink drops. An electrostatic system steers the drops to the paper. Desktop ink-jet printers use either a piezoelectric crystal or a burst of heat from a resistor in the print head to generate ink drops. The heating print head ("thermal ink jet" in Hewlett-Packard parlance, and "Bubble-Jet" to Canon) can be made small. But the ink in a heating ink-jet printer has to be able to withstand the heat, and that further limits the ink choices.

Although some large, expensive ink-jet printers have resolutions as high as those of laser printers, the models on desktops are more comparable to dot-matrix printers. The limiting factor on ink-jet resolution is not the print head but the interaction of the ink and paper.

The thermal/Bubble-Jet ink-jet heads are fabricated using techniques for building ICs, and they can be made small enough to put 1000 ink-dot orifices side by side. Piezo mechanisms tend to be a little bigger, but there are methods (e.g., staggering the orifices) of making a 1000-dpi head with that technology, as well. The trouble comes when all those droplets of ink hit the paper. Unlike the ink in thermal printers, which is fluid only because it is heated, the ink in ink-jet printers is a liquid that soaks into the paper; adjacent dots can bleed together if they are close enough. Because of the characteristics of the printer, ink-jet ink has to flow freely. That is one of the reasons ink-jet printers work best on more absorbent papers.

Hewlett-Packard has been doing extensive research in the area of ink-jet-printer inks for several years. One result was the HP DeskJet, a 300-dpi one-color ink-jet printer that sells for less than $1000 and produces nearly laser-quality print. But the DeskJet also illustrates the problems of high-resolution ink-jet printing. The main complaint about it is that its ink is extremely water-soluble, even after it has dried. Anything printed on a DeskJet has to be kept dry or it becomes illegible. Hewlett-Packard had a lot of trouble finding an ink that would work at 300 dpi, and the DeskJet ink is the best the company could come up with. The problem is worse with color, because different colors can bleed together and change shade noticeably (see figure 1).

One way around this is to use special paper with controlled characteristics. Hewlett-Packard says it could have introduced a 300-dpi color ink-jet printer more than a year ago if it had been willing to take that approach. Instead, the company is concentrating its efforts on making a printer that will work with any common kind of paper. Although Hewlett-Packard isn't saying, observers are betting that it will be at least two years before the company can bring such a printer to market.

One possible method of getting better resolution and color from an ink-jet printer is to vary the dot size. This has the effect of mixing the colors right on the paper.

In multidot printing, the basic unit of ink is much smaller than one full dot's worth, and dots are built up with multiple

*continued*

complete the image. Not only does this cause the usual problems in registration, but laser printers have some special problems as well.

One of them is the toner. A color laser printer has to lay toner over toner in order to produce mixed colors. The whole process is roughly equivalent to trying to paint over wet paint and keep the colors separate. It is also hard to avoid contaminating the toner and getting flecks of misplaced color on the image.

All these problems have solutions, but so far the solutions haven't come cheaply or in a small package. A small color laser printer is pricey and is about the size of a compact refrigerator. Thus, they are not popular as small system peripherals.

This is beginning to change. Traditionally, laser printer technology has been driven by copier technology. In the last several years we have begun to see cheaper, better-quality color copiers. As the technology shakes out, we can expect to see more color laser printers.

### Other Technologies

Several other color printing technologies seem to be making their way toward

*continued*

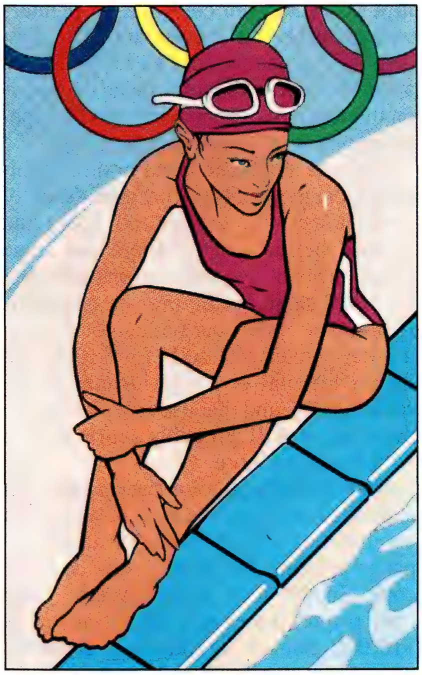

**Figure 3:** *In spite of the 300-dpi resolution, the dot pattern of thermal wax printers looks coarse, because the colors are produced by dithering. In the original printout, produced on a QMS ColorScript 100 printer, this effect is most noticeable on the woman's skin and the water in the pool.*

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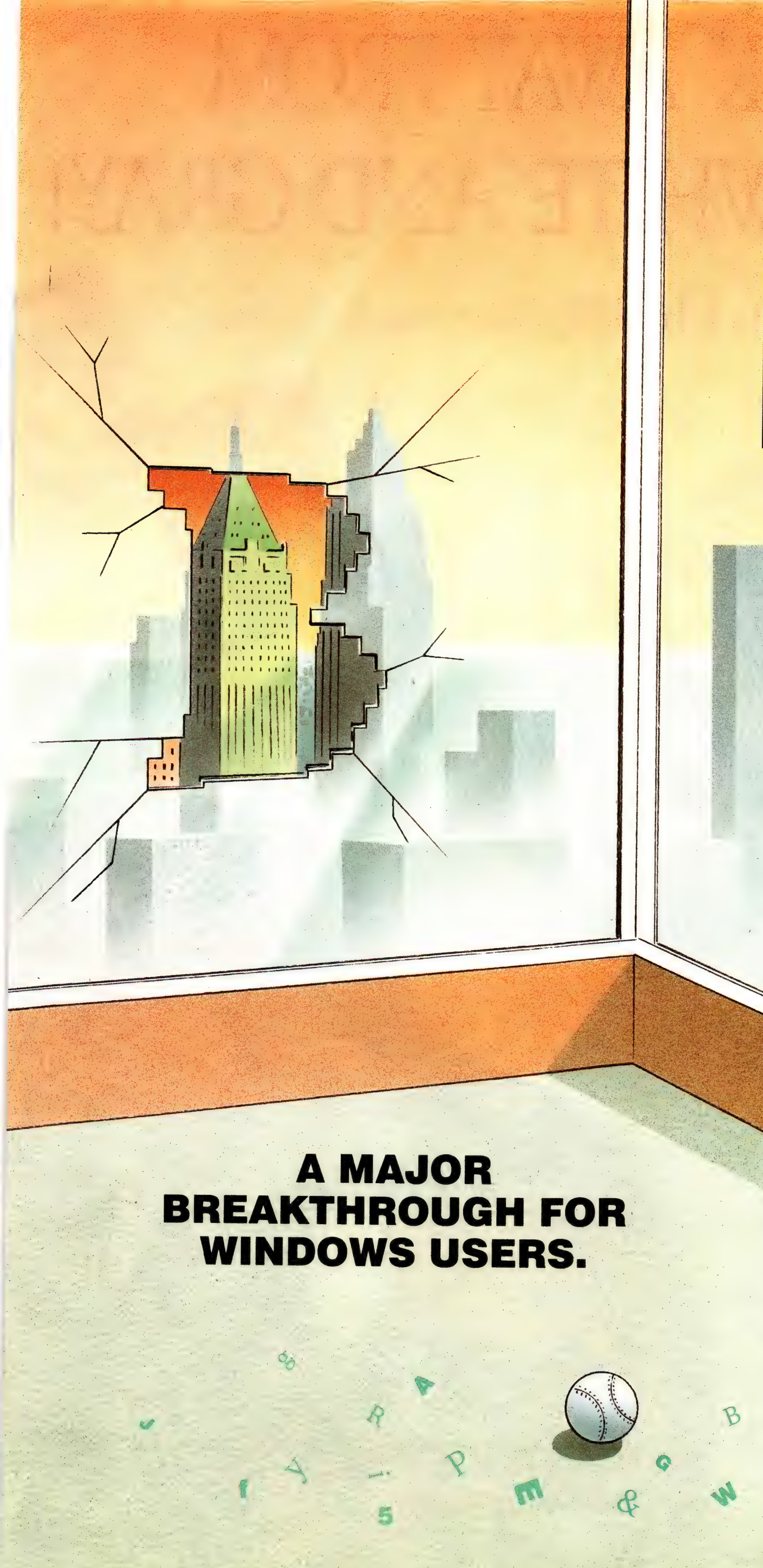

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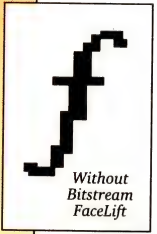

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# THE MIGRATION OF THE X WINDOW SYSTEM

*A standard windowing system may be in everyone's future*

*David Moore*

Windowing systems used to be novel; now they are commonplace. Working with a windowing environment was once a treat; working without one is now a burden. But the windowing systems in use on personal computers today are all different, and it's hard to move an application program from one system to another. Developers can't afford to support all the windowing systems; neither can they afford to restrict their market to users of one system. Consequently, few applications take advantage of any of the existing windowing environments.

For window-based applications to become the norm, a standard windowing system is needed. This is particularly important in the personal computer world, where there are at least three incompatible windowing systems—GEM, Microsoft Windows, and OS/2 Presentation Manager (PM). Ideally, the standard should run on a variety of machines, rather than just on personal computers, so that familiar application products will rapidly support hardware advances (e.g., fast RISC-based machines).

Manufacturers of popular personal computers view the prospect of increased competition from alternative hardware platforms with trepidation. It's easy for them to see increased competition decreasing their market share. It is much more difficult for them to see their sales increasing overall because of an expansion in the size of the market. You cannot look to them for a standard windowing environment.

Fortunately, MIT has been working on the X Window System for many years. This system began as a windowing environment for Unix, but it is spreading to other platforms, including MS-DOS.

## The Origins of X

When Unix first became widespread in the mid-1970s, users worked at teletypewriters and simple video terminals. On the earliest video terminals, text appeared at the bottom of the screen and scrolled up and off the screen as more text was written. These video terminals, commonly called "glass teletypes," were simply more convenient replacements for the terminals that printed on rolls of paper.

The modern video terminal responds to a variety of commands that control how and where text is displayed on the screen. This allows a modern Unix application to format screen output. There are numerous makers of terminals—many with incompatible command sets—but Unix can automatically handle these differences. An application programmer does not have to be familiar with every type of terminal in existence. Instead of writing to

*continued*

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cated to a single task: running an X server. The terminal must be attached—either through a network or through a serial cable—to one or more hosts on which the X clients will be run. The terminal itself cannot run client programs.

It would seem logical that any computer advanced enough to run an X server should be capable of managing other tasks as well. This thinking led to the birth of PC X server software.

A PC X server, in effect, turns your PC into an X terminal for as long as it runs. True to its "terminal" image, it is incapable of executing X clients. What's more, most PC X servers can't run other DOS programs while X is running; X must be suspended until the DOS program is finished.

Quarterdeck Office Systems, maker of the Desqview multitasking environment that runs under MS-DOS, is working on an implementation of X for Desqview. What's unusual about this project is its goal: to provide not only an X server that runs alongside DOS, but an environment under which X client programs can be written and executed on DOS systems. Quarterdeck intends to support both Motif and Open Look and will make developer's packages available for both of these environments, as well as for the basic X interface.

I was fortunate enough to see an early version of this software running on one of Quarterdeck's development machines. Despite the developer's warnings that this was still an early version, the software ran wonderfully.

When I sat down at the demonstration machine, four programs were running—each with its output displayed on a separate, Motif-style window. Only two of the programs were running on the PC; the other two were actually running on a networked Unix box in another room. Quarterdeck's implementation can also run applications on other networked MS-DOS machines running Quarterdeck's version of X. Only a seasoned X user would fail to be impressed by this level of functionality. For each application, Desqview maintains information on where the program is and which directory it is to run in. When running the X environment, you can specify a machine name in addition to a directory name. Once this is done, starting the application is completely transparent to the user.

Of course, as with standard Desqview, you can run all your existing MS-DOS applications in the new environment. You can also run all your existing Desqview-specific software. You can use any of the standard window managers with Quarterdeck's X system. In addition, a window manager that looks and behaves like the standard Desqview window manager has been implemented. This window manager is much smaller than the standard ones.

*The X Window System promises to become the standard windowing environment.*

Quarterdeck is attempting to make the process of transferring software from Unix to X under Desqview as easy as possible. To minimize the changes programmers have to make to their code, Quarterdeck is even implementing a number of Unix C calls that have no real equivalents in MS-DOS.

I am told that the Desqview environment will support virtual memory on both the 286 and 386 and will support programs written using the protected mode available on these processors. Application developers will not have to shoehorn large Unix applications into DOS's 640K-byte memory, although they may have to use a DOS extender to make that extra memory available. The entire environment, including Quarterdeck's window manager, will fit in less than a megabyte of memory, so it will be possible to use Desqview/X on a 2-MB machine. This compares well with OS/2 PM, but with memory costing around $100 per megabyte, memory use is only an issue if your machine lacks expansion capability. If you want to do serious multiprogramming, I recommend 4 MB.

Quarterdeck intends to release a run-time-only version of its X implementation, so developers will be able to sell to all MS-DOS users, not just those who use Desqview/X. This software makes it easier for Unix developers to move their software to MS-DOS. Without a compatible environment, this process is prohibitively expensive for most developers. Not only does it require considerable work to move the software to a foreign platform the first time, but much of the work must be repeated each time there is a new release.

The process will also work the other way: Developers of MS-DOS software will implement under X so that they can later move up to the Unix workstation market with little extra effort.

### X—An Emerging Standard

X promises to become *the* standard windowing environment. It is the only windowing environment that is not tied to a single operating system, and its distribution is not subject to the commercial interests of any one supplier. Anyone who wants to port X to a new system can get the source code free from many locations; you can also buy it from MIT for the cost of duplication. Any machine that supports multitasking and interprocess communication and has a C compiler can support X. Although MIT retains the copyright on X software, it allows the software to be freely distributed, provided that MIT's copyright notices are maintained.

X is already the standard on Unix workstations. It is available under AIX on the PS/2s, Interactive Systems' 386/ix, and The Santa Cruz Operation's Unix System V/386. For larger systems, it can be run on VAXes, Crays, and Data General's MV series, among others. You can also expect to see third-party implementations on OS/2, and probably even on the Mac under System 7.0.

Should developers write to plain MS-DOS, or should they embrace a windowing system? MS-DOS has given good service for a number of years, but it must gradually become obsolete. For all but the largest software companies, making the wrong decision could be fatal. X provides a neat way to avoid this dilemma, and you can expect many developers to embrace it. If some of the larger MS-DOS developers also adopt X, its future as a standard will be ensured, and proprietary windowing systems will come under severe scrutiny. On the other hand, if the large companies do not support X, they could face difficulties as the distinction between personal computers and workstations becomes increasingly blurred.

In any case, the likelihood is that users will demand the ease of use and cross-platform compatibility that only X can deliver. No matter how apparently committed particular vendors are to some proprietary windowing interface, the drive for standards will eventually push them toward X. ■

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*David Moore is a programmer working on FORTRAN for Yarc Systems' (Agoura Hills, CA) AMD 29000 RISC-based computers. He can be reached on BIX as "damoore."*

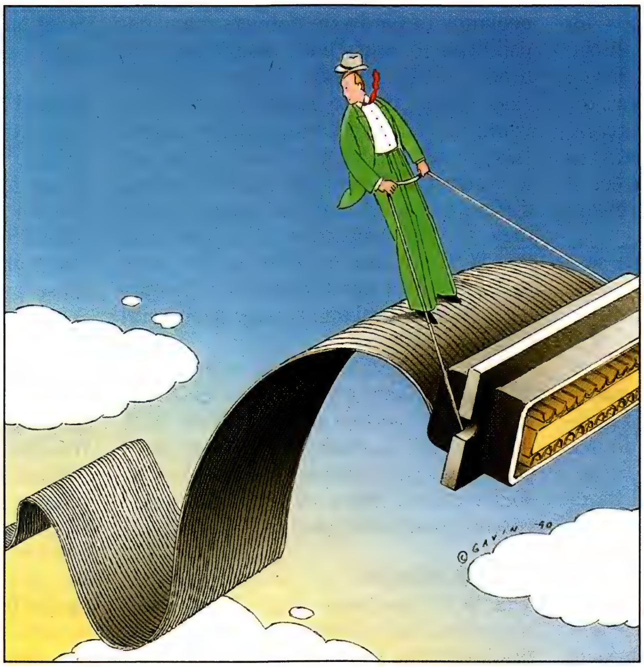
# SCSI: THE I/O STANDARD EVOLVES

*Now in its second revision, the SCSI standard is about to become the universal interface for microcomputer peripherals*

*Bruce Van Dyke*

Over the years, microcomputers have grown to meet the demands of the information industry. New software allowed them to meet these demands. For example, microcomputers couldn't perform CAD jobs until someone wrote CAD software. This is partly because microcomputers' processing power has grown to meet the demands of certain jobs (e.g., file servers managing network cards and large hard disks).

Although the PC's processing power has grown, I/O throughput hasn't. Many file servers don't function at maximum performance because they are I/O bound (i.e., waiting for I/O to a peripheral device to complete). In addition, microcomputers continue to evolve into increasingly complex configurations; this further complicates the performance issue. Today's desktop PC frequently has one or more hard disk drives, a tape backup unit, a network card, a scanner, and a laser printer. Add to that the prospect of emerging storage technologies, such as CD-ROM and optical storage drives, and system complexity grows exponentially.



Trying to get all these devices to cooperate can be a user's nightmare. That's because each peripheral might have a different hardware interface or use a driver that can conflict with other drivers or software. System users must consider these diverse peripherals and help them work synergistically. This is where SCSI comes in. SCSI is a PC interface that boosts I/O performance, while eliminating the difficulties of attaching peripheral devices and reducing software problems.

Although SCSI might be somewhat new to PCs, its origins are much older. SCSI is based on the same architecture as the block-multiplex channel found in early IBM mainframe systems. This I/O bus could deal with several peripherals simultaneously.

In the early 1980s, ANSI started work on a microcomputer I/O bus standard based on the block-multiplex channel functions. This work evolved into a SCSI specification in 1984 and was approved as a standard in 1986 (ANSI X3. 131-1986). For further details on SCSI, see the two-part article "The SCSI Bus" in the February and March BYTE.

Certain microcomputer vendors adopted the SCSI bus some time ago. Apple first used an embedded SCSI bus on its Mac Plus in 1986; every Mac introduced since then has one. Commodore offered a SCSI adapter board for its Amiga 2000 in 1987 and made it an embedded bus on the Amiga 3000. Many workstation vendors also use the SCSI bus to connect to both

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data transfers occur only after both the host and the target device agree to such a transfer. Data is transferred in parallel across the bus, 1 byte at a time, using eight data lines. The typical asynchronous transfer rate is about 2 megabytes per second; the synchronous transfer rate can reach a maximum of 5 MBps.

### SCSI BUS PHASES

**Table 1:** *The various bus states (phases) defined in the SCSI standard. These phases are used to communicate with peripherals, control access to the bus, and transfer data.*

| Phase | Purpose |
|---|---|
| BUS FREE | Bus is available. |
| ARBITRATION | Device obtains control of bus via arbitration. |
| SELECTION | Target device is selected by the initiator. |
| RESELECTION | Target device selects initiator and reconnects to the bus. |
| COMMAND* | Target device requests command information. |
| DATA* | Data is sent to or from target device. |
| STATUS* | The target device requests to send status data. |
| MESSAGE* | Messages are sent to or from the target device. |

*These phases are termed the "information transfer phases."

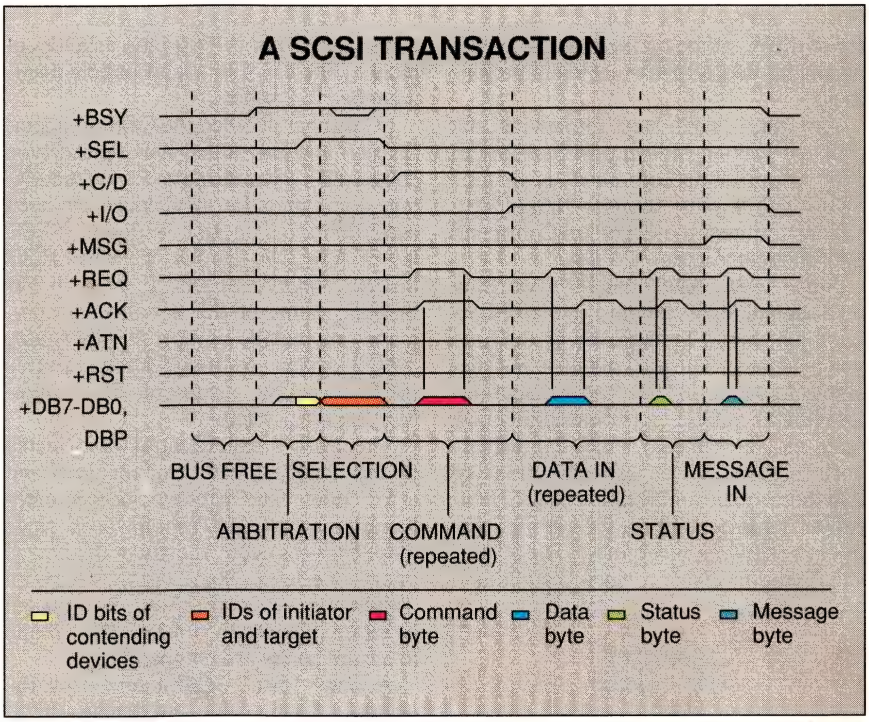

**Figure 2:** *SCSI bus timing. During a transaction, the signals and phases can occur in the sequence shown. The ARBITRATION phase, which was optional in the original SCSI standard, is now mandatory in the new SCSI-2 standard described in the text. The target may disconnect during a lengthy operation, freeing the bus for other devices. The device reconnects later by use of a RESELECTION phase (not shown).*

### What's Your ID?

Every device on the SCSI bus requires a SCSI ID number. These IDs are generally configured with jumpers, although some external Mac peripherals have a thumbwheel for setting them. The SCSI ID serves two purposes: It uniquely defines each peripheral's device address, and it determines the device's priority on the bus during the arbitration phase. The arbitration phase determines which device will own the bus when two or more devices simultaneously request to use it. During arbitration, each data line represents a single device, so there can only be a maximum of eight devices on a SCSI bus. ID 7 has the highest priority, and ID 0 has the lowest. Logical unit numbers are secondary addresses associated with each SCSI ID. There can be up to eight LUNs for each target ID.

The *initiator* is the SCSI bus controller that selects the target device at which commands are directed. The *target* is the SCSI bus controller that receives commands from the initiator. The initiator is generally located in the host computer; the target is typically a peripheral device (e.g., a disk drive or tape drive). Once the initiator selects the target, the target is in complete control of the bus. The data transfer direction is always defined with respect to the initiator. See figure 2 for a typical sequence of SCSI bus phases during an I/O operation.

The SCSI bus allows multiple I/O operations to run concurrently between different devices on the bus. The disconnect and reconnect (D-R) capabilities defined in the standard allow this to happen. D-R lets a device relinquish control of the bus while it is conducting a lengthy operation (e.g., a seek on a disk drive or a tape rewind). This allows other devices to use the bus while that device is busy. When the SCSI bus is free and the device is ready to complete its command, it can reconnect to the bus. This combination of high throughput with multiple device support gives SCSI the potential for handling large applications that require lots of processing power.

IBM is using SCSI to maximize performance and peripheral connectivity in the Micro Channel architecture. Moreover, SCSI is expected to become the peripheral I/O interface for other architectures, such as EISA. Almost every major peripheral device manufacturer now offers SCSI products. Some devices (e.g., CD-ROM) rarely have other interfaces.

### Enter SCSI-2

The first SCSI peripherals suffered from compatibility problems. These problems existed not because there was an inadequate standard or a faulty device design, but because there was too much flexibility in the specification. The original specification (SCSI-1) allowed so many variations in a SCSI controller implementation that the early SCSI peripherals weren't compatible. For example, the use of parity on the bus was an option: SCSI peripherals that used parity obviously wouldn't work with devices that didn't. Also, there were numerous permutations of the SCSI commands; this led individual device manufacturers to

*continued*

manufacturer's implementation.

The ASPI architecture reduces the number of software drivers required to support a host adapter and its peripherals under various operating systems. ASPI's modular design lets you use only the drivers that go with your SCSI peripherals. As you add more devices, you add the corresponding interface modules. ASPI also facilitates the addition of new devices without disturbing the existing drivers or peripherals.

*A more radical approach that is being considered is implementing the SCSI bus by using optical driver technology.*

Microsoft has adopted a software architecture for OS/2 that is similar in approach to ASPI. Its layered device drive architecture, called LADDR, defines an application programming interface that is independent of the host adapter. This approach simplifies support for multiple host adapters and allows up to seven SCSI devices per adapter.

### The Future: SCSI-3

As SCSI-2 nears completion, work is under way for a SCSI-3 standard. Although it is in its early stages, the proposed features for SCSI-3 include a 16-bit data path on a single 68-pin connector; more than eight SCSI IDs on a SCSI bus; longer cable lengths; bus fairness; more command sets (e.g., digital audio tape and file server); and a fiber-optic option as an alternative data transfer medium.

SCSI-3 will probably be the first to implement wide SCSI. SCSI-3 uses the SCSI-2 high-density 68-pin connector (the B cable) for the primary cable instead of the standard 50-pin A cable defined in SCSI-2. You can connect both the 68-pin and 50-pin devices to the same cable because there are nine new signals added to each side of the 50-pin connector. This connector will provide peripheral manufacturers with a smaller footprint while adding the flexibility to either implement 16-bit wide SCSI or remain in standard 8-bit mode.

Since SCSI-3 proposes a 16-bit data path on a 68-pin cable and a 32-bit data path with a second 68-pin cable, 32 devices or IDs can be supported on the bus. A proposed "fairness" scheme would periodically give the bus to devices with lower IDs that have not been able to win arbitration.

Placing 16 devices on a 6-meter, single-ended cable will be a difficult task, because most of the devices may be located in an external cabinet. The industry expects that improvements in terminator designs and driver technology will be required to facilitate this change and to support fast SCSI. Single-ended drivers may not be able to support fast SCSI (10 MBps) at the maximum 6-meter cable length. However, internal devices on a properly terminated short cable should work. Differential drivers should provide the signal quality necessary to drive a cable of more than 6 meters at fast transfer rates.

A more radical approach being considered is implementing the SCSI bus by using optical driver technology. This could stretch the SCSI cable well beyond its current length limits while still maintain high-speed data transfer. A fiber-optic implementation would use information packets for data transmission—a dramatic departure from the current architecture.

It might seem premature to consider what's beyond the SCSI-2 standard, especially since it will take time for SCSI-2 features to show up in today's peripherals. Nevertheless, this shows the success of the SCSI standard itself. Even IBM has adopted SCSI for its peripherals; that makes the SCSI bus more universal than either the Mico Channel or EISA. It promises not only to establish an I/O bus standard on microcomputers, but to make peripheral devices accessible to all computer users, no matter what platform or operating system they use.

Hardware standards provide definitions that allow different machines and technologies to connect and communicate, and SCSI seems to have succeeded in this area. However, as existing technologies become faster and new technologies evolve, then the standards must evolve as well. SCSI is evolving to meet these new demands. ■

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*Bruce Van Dyke is an applications engineer at Adaptec, Inc. (Milpitas, CA). He can be reached on BIX c/o "editors."*

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# DATA TO THE DESKTOP: THE SQL ADVANTAGE

*The plethora of SQL implementations limits data exchange*

*Robert J. Crutchfield*

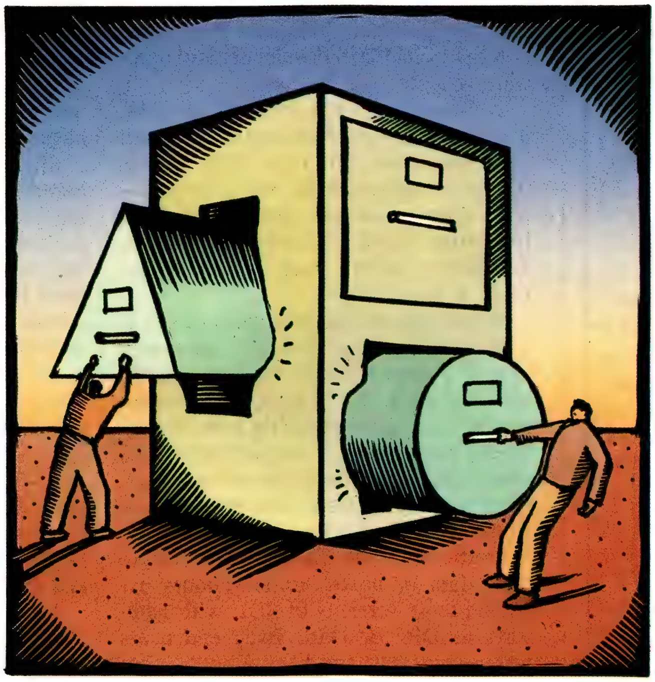
While the 1980s will be remembered as the era of the microcomputer revolution, the 1990s are shaping up as the age of the database explosion. The battle for the desktop has been won. Microcomputers are more powerful than ever, and the increased processing power is being used for applications traditionally reserved for minicomputers and mainframes, like database management. The desktop has become a window to access corporate information.

### Broader Access

Indeed, we have undergone an information revolution. Users now have access to more information than ever. This is due to the changing computer environment—that is, moving from host-based to network-based systems. The decentralization or flattening out of the corporate structure, coupled with the desire to move information closer to the people, has greatly changed the data-processing shop. The data center has evolved from single-vendor computing to a decentralized multivendor environment.

During the 1980s, spreadsheet vendors like Lotus and VisiCalc turned a generation of middle managers into accountants and, at the same time, created one of the most widely used PC applications of the decade. In the 1990s, developers of advanced fourth-generation languages and computer-automated software engineering tools have the potential to turn today's users into programmers. Granted, there will always be a need for professional software developers. However, the applications backlog is forcing many users to develop applications using 4GLs. And many of these applications are used in conjunction with databases.

Over the last decade, database management has evolved from a mundane, "glass room" process into a process that offers companies a competitive advantage through applications like on-line transaction processing, decision support, and executive information systems. Structured Query Language (SQL) based relational databases, the client/server architecture, improved user interfaces, and distributed computing are all allowing users greater access to almost instantaneous information to make mission-critical business decisions.



The relational model of data was introduced by Dr. Edgar F. Codd in 1969. The IBM Research Labs developed SQL in 1974 to support the Codd model; it was designed to interrogate and process data in a relational database.

SQL is rapidly becoming the preeminent database structure because of its functionality and its flexibility. SQL-based relational data-

*continued*

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## Forging a Standard

Client/server computing is rapidly advancing information management. This architecture benefits users while creating challenges and opportunities for MISes, database administrators, hardware vendors, and software developers alike.

With many companies using multiple relational database management system products on multiple hardware platforms, it will be a major challenge to manage information that is scattered across an organization under different RDBMSes and various computing environments. And although advances in multivendor integration enable different systems to be networked together in a distributed computing environment, Structured Query Language (SQL) based RDBMSes and application tools from different vendors still do not have the ability to interoperate.

Recognizing this problem, a group of companies, including Ingres, Sun Microsystems, Digital Equipment, and Tandem Computers, began meeting informally to discuss how to achieve interoperability and portability of SQL-based RDBMSes. These vendors determined that while standards organizations like ANSI and the International Standards Organization (ISO) had made progress toward standardizing SQL, their work did not go far enough to solve the RDBMS interoperability problems in multivendor environments.

Out of these early meetings, the SQL Access Group was formed. The group's mission is to develop a technical specification that will allow one vendor's SQL application to access data in other vendors' SQL servers, thus enabling RDBMSes and application tools from different vendors to work together.

The SQL Access Group published its technical specification last March and plans to demonstrate a working prototype in early 1991, running on the hardware and software of the various member companies. The work is based on existing standards developed by ANSI and ISO, as well as guidelines published by the X/Open Consortium's Portability Guide.

The group's work is in response to the growing need for users to create applications that will operate with multiple RDBMSes, regardless of the platform the data resides on. The group is tackling two major technical barriers that currently prevent intervendor SQL access; eliminating them would allow users to operate more than one heterogeneous SQL RDBMS at a time.

First, each brand of SQL is different. While the ANSI committee sets standards, many areas of ANSI SQL (SQL 1, 1986) are left up to the user or vendor to define. The SQL Access Group is standardizing many of the implementer-defined items in the application programming interface, including:

- Association management statements (connect, set connect, and disconnect)
- Three-level object names
- Standardized system catalog name
- New catalog tables (SQL languages and server defaults)

Second, because of the different client communication protocol, one vendor's SQL client cannot connect to other vendors' SQL servers across the wire because of the different client/server protocol and client/server message formats. Standardization of SQL communication is handled by the ISO's Remote Data Access committee. The SQL Access Group is making the following contribution to the ISO/RDA Formats and Protocols work:

- Mapping of SQL statements to RDA services
- Encoding of SQL data (including ASCII and EBCDIC)
- Authentication and access control
- Diagnostic messages
- Choice of communication protocol
- Extended Get Diagnostics statement
- Inclusion of Dynamic SQL (RDA currently doesn't allow it)

The SQL Access Group will make its technical specification available to the X/Open Consortium for inclusion in the 1991 edition of its Portability Guide.

The SQL Access Group (996 Redondo Ave., Suite 515, Long Beach, CA 90804, (213) 438-5788) is a nonprofit association and is open to all vendors of RDBMS or server products. There are two levels of membership: reviewers and producers. Reviewers have access to the technical specification and provide feedback to the group. Producers must also provide technical resources, in the form of software developers and equipment, to help develop the technical specification.

The group was founded in 1989; its members include Ashton-Tate, Bull, Cincom Systems, Digital Equipment, Fujitsu America, Hewlett-Packard, Infocentre, Informix, Ingres, Metaphor, Microsoft, NCR, Oracle, Progress Software, Retix, Sun Microsystems, Sybase, Tandem Computers, Teradata, Unify, and X/Open.

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market and to respond to user needs. As more power is moved closer to the user, companies are changing the way they allocate computer resources. The trend over the last several years has been toward decentralization. Now, instead of companies keeping all their data on centralized mainframes, they distribute the information throughout the enterprise to minicomputers and workstations. Large corporations often have one brand of mainframe and other brands of minicomputers and workstations. In fact, large computing environments usually have a mix of on-line transaction processing software, application development tools, RDBMSes, and hardware, along with user-developed applications and off-the-shelf software.

Decentralized or distributed computing is an excellent way to put information closer to the user. Over the last few years, the client/server architecture has enabled companies to access and manage their data more efficiently. Today, workstations perform many database operations that were once relegated to minicomputers or mainframes. They let users update, store, and send data without having to rely on a host computer.

In client/server computing, the client, or workstation, sends requests for data to the server (which is usually a minicomputer or mainframe) and then receives data. The server receives requests and sends data. SQL-based RDBMSes play an important role in client/server computing. On the client, or front end, a

*continued*

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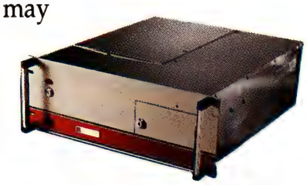

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*Circle 191 on Reader Service Card*

# MAKING THE MICRO-TO-MAINFRAME CONNECTION

*A guide to linking up with the Big Iron*

Sharon Fisher

A communications protocol can be crowned a "standard" in one of three ways: If a standards body passes it (i.e., de jure), if public use demands it (i.e., de facto), or if IBM says so.

Protocols that a single vendor defines and supports are called proprietary protocols. These days, with the move toward standards, proprietary protocols are not really politically wise. However, because so many users need to communicate with IBM mainframes, people tend to look at IBM proprietary protocols as a necessary evil.

If you want your PC to communicate with an IBM mainframe, you're probably going to have to do it IBM's way. And IBM's way consists of a group of arcane, somewhat technically outdated protocols that are only slowly becoming more modern.

## Playing Dumb

The glacial pace of these upgrades is due to the massive installed base of IBM mainframe applications designed for use with dumb terminals. Some of these applications have been in use for 20 years.

Despite the rapid increase in the PC's power, the mainframe is going to be around for a long time—it still provides a cost-effective way to connect many users and to store vast amounts of data.

While you can upgrade an organization's dumb terminals to intelligent PCs relatively quickly, upgrading the applications to use the PC's intelligence isn't so easy. It requires completely redesigning and rewriting the applications—a luxury that most companies don't have. The applications backlog in many organizations is measured in months or years. There's little point in rewriting these applications when firms don't have the time to fix applications that are "broken."

Consequently, many PCs communicate with a mainframe and its applications by pretending to be dumb terminals. This can produce some ironic effects (e.g., paying more than $500 for a board that turns a $2000 PC into a $1000 terminal), but it lets you gain the advantages of an intelligent PC while retaining backward compatibility with mainframe applications.

This process is called *terminal emulation.* When you talk about communicating with an IBM mainframe, it's called *3270 terminal emulation* (after the family of IBM terminals that the PC is pretending to be). The actual terminal being emulated may be a 3279 or 3278, depending, for example, on whether or not the PC supports color. Several models of terminals (models 2 through 5) are defined based on screen size—from 25 to 48 rows, and either 80 or 132 columns.

*continued*

ILLUSTRATION: JOHN BREAKEY © 1990

configuring a large number of PCs is tedious and requires more mainframe resources. Some organizations do both: They individually configure some PCs (perhaps those that are used the most or that are used for different functions), and they create a pool of mainframe sessions that other users can share.

### Talking the Mainframe Talk

In the same way that LANs require both adapter cards and network operating-system software to function, micro-to-mainframe communication has both hardware and software components. If you just want your PCs to act as terminals to the mainframe, all you need is terminal-emulation software. If you wish to write programs for the PCs that communicate with programs on the mainframe, you need additional software.

The type of software that organizations use depends on what kind of application programming interface they want for the mainframe. There are three kinds of APIs, which require increasingly more programming on the mainframe side than the one before it.

The first type is High-Level Language API (HLLAPI). With software that supports this interface, you can write applications that communicate with mainframe applications as though they were terminals. The mainframe applications don't need to be modified to communicate with the PC applications. You would use this type of interface for programs that transfer files between the PC and the mainframe.

In earlier software releases, IBM also supported Entry-Emulator HLLAPI. This provided a subset of HLLAPI and was designed for use with smaller, simpler LANs. EEHLLAPI is no longer available.

The second type of API is Server-Requester Programming Interface (SRPI). With software supporting this interface, you can write applications that treat the mainframe as a server by communicating with relational databases on the mainframe. However, to provide this function, the mainframe also requires another type of software, Enhanced Connectivity Facility (ECF). This type of interface is used for programs that extract data from a mainframe database.

The third type of API is Advanced Program-to-Program Communication. APPC differs from the other two APIs. In other types of communication, the mainframe "master" transmits and receives data from a PC "slave." With APPC, the mainframe and the PC are peers, and either one can request information from the other. You would use this type of interface for client-server applications, where both the PC and the mainframe do some of the processing. However, to support APPC, you must write programs on the mainframe; you cannot use the existing applications that were written for dumb terminals.

APPC also uses a different type of communications protocol than the other two APIs. While HLLAPI and SRPI can communicate with the mainframe by using 3270 protocols, APPC uses a type known as Logical Unit 6.2 (LU 6.2).

LU 6.2 supports peer-to-peer communication on the hardware level; APPC provides it on the software level. However, the two terms—APPC and LU 6.2—are often used interchangeably.

Another term often associated with APPC is System Network Architecture. IBM is attempting to migrate its users toward a certain group of strategic communications protocols; it uses the term SNA to refer to these protocols. APPC/LU 6.2 are in SNA; 3270 communications protocols are not.

### The Software Connection

The type of software you need depends on the APIs you choose and what operating system your PCs run. For example, many vendors offer 3270 terminal-emulation software for use with MS-DOS and OS/2. This software generally supports HLLAPI and other basic programming interfaces. If you want to support APPC, you need additional DOS software.

IBM recommends that OS/2 users who want both 3270 terminal emulation and support for APPC should move to OS/2 Extended Edition. Extended Edition includes a communications manager that provides both of these functions. Another advantage of Extended Edition is that it supports Ethernet LANs as well as Token Ring networks.

The two major vendors for PC communications hardware and software are IBM and Digital Communications Associates. These vendors provide products like 3270 terminal-emulation boards, terminal-emulation software, and gateway hardware and software. But more than a dozen other vendors also provide some subset of these products.

At present, Extended Edition/Communications Manager is available only from IBM. However, IBM announced in November 1989 that it would make its Communications Manager functions available to other vendors for incorporation into their products. IBM has not yet said how or when it will do this.

Some organizations wish to make their micro-to-mainframe programs user-friendly, yet don't have time to rewrite the entire application. Many vendors have released products that let you develop icon- and menu-driven interfaces for their applications without requiring changes in the mainframe application.

### Futures

At this point, IBM and the marketplace are pushing users toward communications methods that take advantage of the PC's intelligence (e.g., Token Ring connections and APPC) for writing new applications. The new crop of client-server OS/2-based applications demonstrate the value of this method.

Moreover, in response to user demand, IBM is beginning to support types of communication other than those it has developed itself. For example, OS/2 Extended Edition supports Ethernet LANs as well as Token Ring networks.

IBM has said that it will support Open Systems Interconnection protocols, which are intended to be used by all vendors to let you set up heterogeneous networks of computers. In addition, IBM is already beginning to support TCP/IP, a set of older communications methods that many vendors support and many products provide now.

On the other hand, the mainframe isn't likely to go away. While new micro-to-mainframe communications possibilities are opening up, the huge installed base of mainframe applications will guarantee that older terminal-emulation protocols and the applications that support them will continue to be used for the foreseeable future. ■

Editor's note: *For more information on micro-to-mainframe communications, contact Attachmate (13231 Southeast 36th St., Bellevue, WA 98006, (800) 426-6283 or (206) 644-4010) and ask for the "Evaluator's Guide to 3270 Micro-Mainframe Products." Although Attachmate produces its own line of 3270 products, most parts of this guide are fairly bias-free and do a good job of presenting the information.*

ACKNOWLEDGMENT

*Thanks to Bob Spaziano, consulting support representative for LANs of IBM's telecommunications system support center, for providing some of the information in this article.*

---

*Sharon Fisher is a San Francisco–based freelance writer specializing in computer communications. She can be reached on BIX as "sharonfisher."*

# DON'T WORRY, USE HLLAPI

*Cooperative applications development that involves both microcomputers and mainframes draws on the strengths of each*

*Mike Fichtelman*

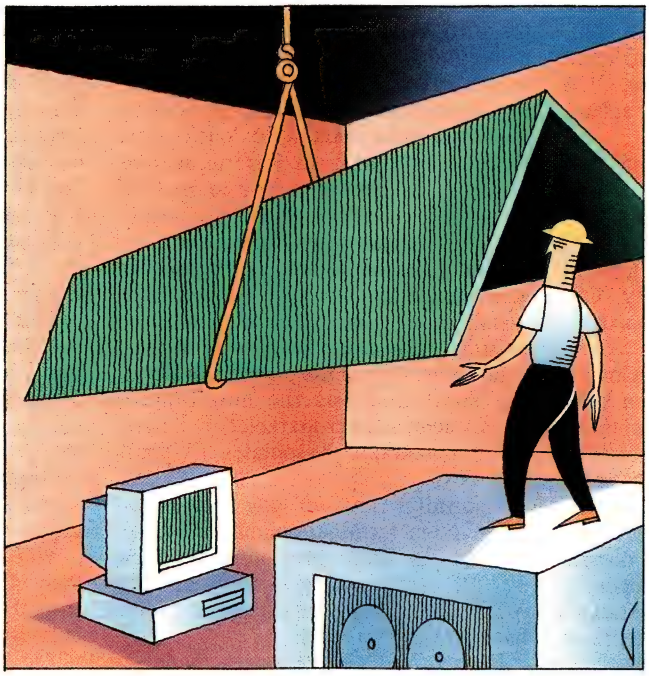
One of the biggest surprises of the last decade, at least to IBM, was the phenomenal success of the IBM PC. IBM's original sales projections for the PC indicated that only about a quarter-million of the little machines would be sold. Of course, these projections may have been skewed by IBM's interest in mainframe computers—IBM makes a 60 percent profit on every mainframe. Therefore, just about everything that IBM does, makes, or sells is traditionally geared toward bolstering the sale of mainframes.

Despite IBM's predilection for mainframes, sales of PCs grew far beyond the original projection. People all over the world, in homes, offices, and factories, are using PCs to do just about everything that a "real" computer can do. In fact, the balance has shifted so dramatically that last year sales of PCs eclipsed sales of mainframes for the first time.

The reasons for this are simple. Given a choice between a mainframe terminal and a personal computer, people will almost always choose the latter. A personal computer is under your control. Response time and performance are usually excellent, because you're not competing with hundreds of other users for the machine's attention.

Personal computers are also easier to use. Applications can be built using virtually endless levels of help screens, windows, and other techniques that make using the application more intuitive.

These kinds of things can't be done on a mainframe without enormous expenditure and effort. It's like giving people a choice between a black-and-white TV and a color TV. Just as most people will take the color TV, most people will take a personal computer over a mainframe terminal.



In the mid-1980s, IBM began to realize that mainframe sales were ebbing away to the less profitable but enormously popular PC. But wait a second. What about all that information on the mainframe, all those huge data files? What about the tremendous investment that companies all over the world have made in mainframes and mainframe data communications networks?

To keep the PC people in the game, protect customer investment, and salvage its bread-and-butter business, IBM began to produce alternatives that were needed to provide connectivity between PCs and mainframes. Enter Systems Application Architecture (SAA).

## You don't SAA

PCs weren't the only reason for IBM's sagging sales. Another culprit was IBM's disjointed product line. IBM produces a large portfolio of software products that run on

*continued*

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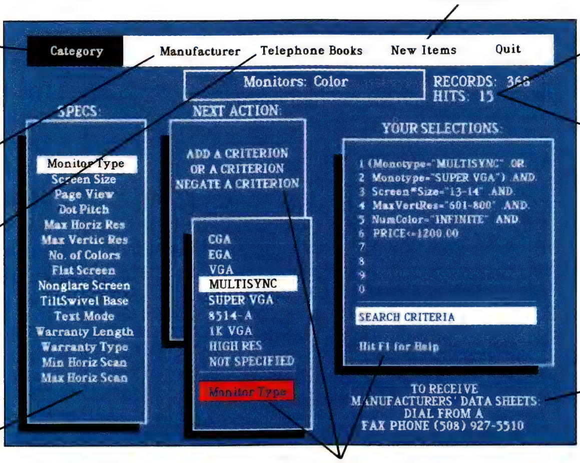

```
Category   Manufacturer   Telephone Books   New Items   Quit

            Monitors: Color                 RECORDS: 368
                                            HITS: 15
SPECS:              NEXT ACTION:
                                                 YOUR SELECTIONS:
Monitor Type        ADD A CRITERION
Screen Size         OR A CRITERION          1 (Monotype="MULTISYNC" OR
Page View           NEGATE A CRITERION      2 Monotype="SUPER VGA") AND
Dot Pitch                                   3 Screen*Size="13-14" AND
Max Horiz Res                               4 MaxVertRes="601-800" AND
Max Vertic Res          CGA                 5 NumColor="INFINITE" AND
No. of Colors           EGA                 6 PRICE<=1200.00
Flat Screen             VGA                 7
Nonglare Screen         MULTISYNC           8
TiltSwivel Base         SUPER VGA           9
Text Mode               8514-A              0
Warranty Length         1K VGA
Warranty Type           HIGH RES            SEARCH CRITERIA
Min Horiz Scan          NOT SPECIFIED
Max Horiz Scan                              Hit F1 for Help
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# Power C

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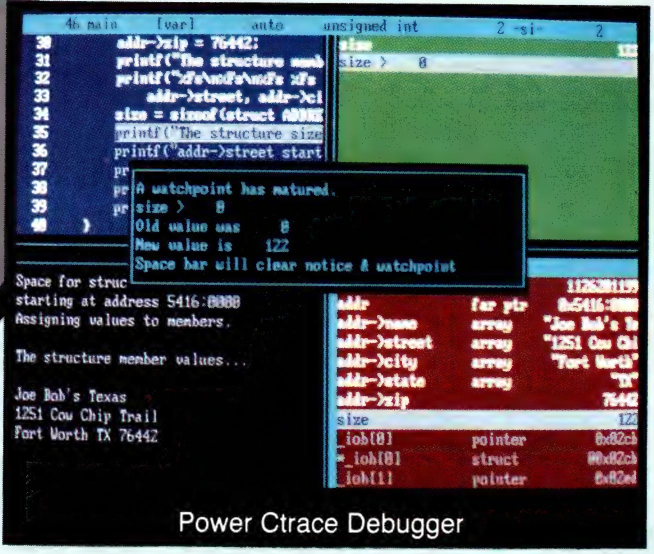

```
 4b main     [var]      auto    unsigned int        2 -si-     2
   addr->zip = 76442;                          size
   printf("The structure memb                  size >    0
   printf("%s\n%s\n%s %s
       addr->street, addr->ci
   size = sizeof(struct ADDRE
   printf("The structure size
   printf("addr->street start
   pr
   pr A watchpoint has matured.
   pr size >    0
   }  Old value was     0
      New value is    122
      Space bar will clear notice & watchpoint
Space for struc
starting at address 5416:0000                                  1126301159
Assigning values to members.           addr          far ptr   0x5416:0000
                                       addr->name    array     "Joe Bob's Te
The structure member values...         addr->street  array     "1251 Cow Chi
                                       addr->city    array     "Fort Worth"
Joe Bob's Texas                        addr->state   array            "TX"
1251 Cow Chip Trail                    addr->zip                     76442
Fort Worth TX 76442                    size                            122
                                       _iob[0]       pointer        0x82cb
                                       *_iob[0]      struct         00x82cb
                                       _iob[1]       pointer        0x82ed
```

Power Ctrace Debugger

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PC Magazine, September 13, 88 (Review)

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Michael Cortese
Computer Shopper, August 88 (Review)

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Computer Shopper, November 88 (Review)

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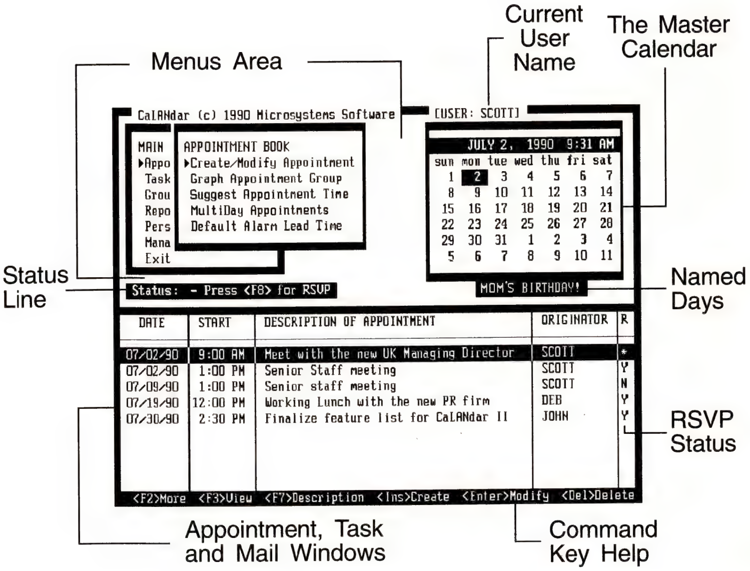

```
CalANdar (c) 1990 Microsystems Software          [USER: SCOTT]

MAIN   APPOINTMENT BOOK                          JULY 2,  1990  9:31 AM
▸Appo  ▸Create/Modify Appointment              sun mon tue wed thu fri sat
 Task   Graph Appointment Group                  1   2   3   4   5   6   7
 Grou   Suggest Appointment Time                 8   9  10  11  12  13  14
 Repo   MultiDay Appointments                   15  16  17  18  19  20  21
 Pers   Default Alarm Lead Time                 22  23  24  25  26  27  28
 Mana                                           29  30  31   1   2   3   4
 Exit                                            5   6   7   8   9  10  11

Status:  - Press <F8> for RSVP                      MOM'S BIRTHDAY!

 DATE      START     DESCRIPTION OF APPOINTMENT                 ORIGINATOR  R

07/02/90   9:00 AM   Meet with the new UK Managing Director     SCOTT       *
07/02/90   1:00 PM   Senior Staff meeting                       SCOTT       Y
07/09/90   1:00 PM   Senior staff meeting                       SCOTT       N
07/19/90  12:00 PM   Working Lunch with the new PR firm         DEB         Y
07/30/90   2:30 PM   Finalize feature list for CaLANdar II      JOHN        Y

 <F2>More  <F3>View  <F7>Description  <Ins>Create  <Enter>Modify  <Del>Delete
```

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*Circle 222 on Reader Service Card (RESELLERS: 223)*

# ADDING VALUE TO YOUR DATA

*Whatever way you choose to share data, the process is essential*

*George Bond*

D*ata sharing* is one of those phrases whose fuzziness masks the immense value of what it describes. Its meanings and uses span a wide range. Moving data from one computer to another is so central an issue that it is impossible to overstate its importance.

Data sharing can mean slipping the answers to today's quiz to the kid across the aisle in an elementary-school history class. Or it can refer to the National Oceanic and Atmospheric Administration computer's pulling weather data from sensors and broadcast gear in a satellite miles above the earth and feeding it into a network that your local TV weatherperson uses to prepare the 6 p.m. report.

In down-to-earth, real-world terms, data sharing can mean maintaining a central file of procedures and functions for use by a programming team, the pooling of mortality statistics by insurance companies, or providing a statewide master card catalog for libraries.

You can even share data with yourself by cutting and pasting between applications, doing mail merges, importing information, or using Dynamic Data Exchange (DDE) procedures. You can share data with others through something as simple as a null modem (or a peer-to-peer, zero-slot LAN).

Despite its importance, the world of data sharing is far from robust. The lack of hardware and software standards has caused enough problems to drive many users back to their isolated PCs after tentative and often unsuccessful attempts to talk with the world. Users have needlessly rekeyed millions of characters instead of having them read from a file.

Thousands and thousands of people use databases, telephone directories, and accounting systems that don't really meet their needs. They do so because it takes too much work to manually transcribe years of data from an old program to a new and improved one. What follows is a discussion of basic ways that you can share data and of what tools are available that you can use today.

ILLUSTRATION: KAREN STOLPER © 1990

## Footpower Transfers

The "sneakernet" is the simplest way to share data between one computer and another. You store data on a floppy disk in computer A, remove the disk, carry it to computer B, insert it in a disk drive, and read it. It is simple, fast, and cheap.

Of course, this method of sharing data assumes that both computers use compatible disk formats and sizes (your PS/2 will have problems reading a disk from your DEC Robin). It also assumes that the programs that generate the data are compatible (for

*continued*

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LAN TIMES
RECOMMENDED NETWORKING

PC MAGAZINE
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March 28, 1989
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*Based on manufacturer's suggested retail price for a 10-computer LAN using LANtastic 2Mbps adapters. Cost is slightly higher for smaller networks. ©1990 ARTISOFT. LANtastic is a trademark of Artisoft.

and they are a breeze to configure.

LapLink, Brooklyn Bridge, and File Shuttle are examples of available products in this market. Some of these transfer programs have become so sophisticated that they are virtually a LAN for a pair of computers; besides doing all the error checking needed to transfer both text and binary files, they allow you to use remote printers and disks. Unlike a full-featured LAN, however, these programs operate in a master/slave configuration. When you are using a disk on the remote computer, that computer cannot be used from its keyboard.

### Plugging into the World

The next step up from a null-modem connection is a real, physical modem connection. Although you lose speed with a real modem, you gain distance. Null modems have a limit of 50 to 100 feet for serial connections and about 12 feet for parallel connections.

Null-modem serial connections allow data transfers at speeds exceeding 115K bytes per second; parallel connections allow for much faster transmission. Consumer modem speeds top out at 19,200 bps. But real modem connections can span continents and oceans if necessary (as long as the modem on the receiving end is compatible with that on the sending end).

The two basic types of external modems are *acoustic-coupled* and *direct-connect.* Acoustic modems make no permanent connection with the telephone system. Instead, they use transducers that press against a telephone handset's mouthpiece and earpiece.

Acoustic couplers don't handle high data speeds well. They are mostly relics today, but they still have some valuable uses. For instance, if you're stuck in a hotel room where the telephone cable is anchored into the wall the way Excalibur was anchored into the stone, acoustic couplers are essential. A 300-bps transmission through electronic earmuffs on the phone is better than no transmission at all. And technology is changing things, as usual. For example, a new modem from Eurolink comes with an acoustic coupler that the company says supports speeds of up to 4800 bps with MNP level 5 data compression.

You can obtain both external or internal direct-connect modems. External modems have one or two phone jacks and one serial connector. You plug a phone cord into one of the jacks in the modem, and the other end into the telephone wall outlet, just as you would plug in a phone. The jacks are generally RJ-11 and accept a standard Bell Telephone extension cable. Often, the modem has a second jack to allow connecting a telephone to the line. Internal direct-connect modems also come as self-contained cards that fit into a bus slot and provide their own serial connection.

The slowest standard modem these days operates at 300 bps. I've seen these modems advertised for as little as $25, and selling for $2 to $5 at swap meets. Unless you're on an absolutely rock-bottom budget, don't bother with them. Get at least a 1200-bps modem ($50 to $100) or, better yet, a 2400-bps unit ($75 to $200). If you need to move large amounts of data, consider 9600-bps or faster modems ($600 and up). The 1200-bps modems are probably the most common today, but as prices fall, 2400-bps units are catching up fast.

Both the acoustic and direct-connect modems require a serial card that you can configure as a communications port on your computer. COM1 and COM2 are the most common, but you can often use COM3 and COM4 as well.

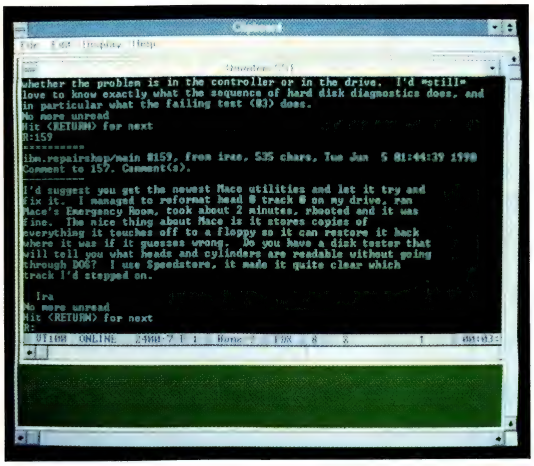
There are some amazing telecommunications software packages on the market today—public domain and shareware as well as commercial. You really have to look hard to find a bad one. You may find an interface you don't like, but the program is likely to do what it says it will do, and do it well.

Sophisticated packages like Crosstalk for Windows and DynaComm can support DDE while running in the background and can feed numeric data directly into an Excel spreadsheet. Kermit, a public domain program, can interact with everything from mainframes to microcomputers. With shareware programs (e.g., Telix, Qmodem, and Procomm) that include command languages, you can automate much of your telecommunications activity. If you choose other software (e.g., Remote2 and Carbon Copy), you can set up one computer as a host and and control it remotely from another computer. For example, you could run Remote2 on your office desktop while you travel and have access to all your files from the field.

Data telecommunications with on-line systems may be the best way to share data. No one knows for sure how many public computer BBSes exist today, but estimates for the U.S. alone begin at 6000 and go as high as 15,000. Most of these are free services run by individuals or companies.

Their content ranges from civil rights, freedom-of-the-press, and National Rifle Association gun policy support to product support. There are specialized BBSes for pilots, doctors, health-food fanciers, Buddhists, channelers and mystics, children, senior citizens, members of Alcoholics Anonymous and other 12-Step groups, and science fiction fans. You name it...there's probably a BBS group somewhere that addresses issues that interest you. Thousands of megabytes of text and program code are available for the price of a phone call.

Many commercial BBSes exist as well. Among those that provide information at moderate prices are BIX, CompuServe, GEnie, Delphi, Dow Jones, and a dozen or so others (see photo 2). High-end services that cost $25 per hour and up (e.g., Nexis and Dialog) provide specialized information on demand. This may be the ultimate in data sharing. When you use one of these services, you literally have the collected wisdom of the world sitting in data banks waiting for you to drop by and collect it. ■



```
whether the problem is in the controller or in the drive.  I'd *still*
love to know exactly what the sequence of hard disk diagnostics does, and
in particular what the failing test (03) does.
No more unread
Hit <RETURN> for next
R:159
==========
ibm.repairshop/main #159, from irae, 535 chars, Tue Jun  5 01:44:39 1990
Comment to 157. Comment(s).
-----------
I'd suggest you get the newest Mace utilities and let it try and
fix it.  I managed to reformat head 0 track 0 on my drive, ran
Mace's Emergency Room, took about 2 minutes, rbooted and it was
fine.  The nice thing about Mace is it stores copies of
everything it touches off to a floppy so it can restore it back
where it was if it guesses wrong.  Do you have a disk tester that
will tell you what heads and cylinders are readable without going
through DOS?  I use Speedstore, it made it quite clear which
track I'd stepped on.

  Ira
No more unread
Hit <RETURN> for next
R:
```

**Photo 2:** *One way of sharing data is on a BBS. Shown here is a screen from BIX, which has several hundred different interactive conferences covering a huge variety of subjects.*

---

*George Bond is a communications consultant with more than 20 years' experience and a cofounder of BIX. You can reach him on BIX as "gbond."*

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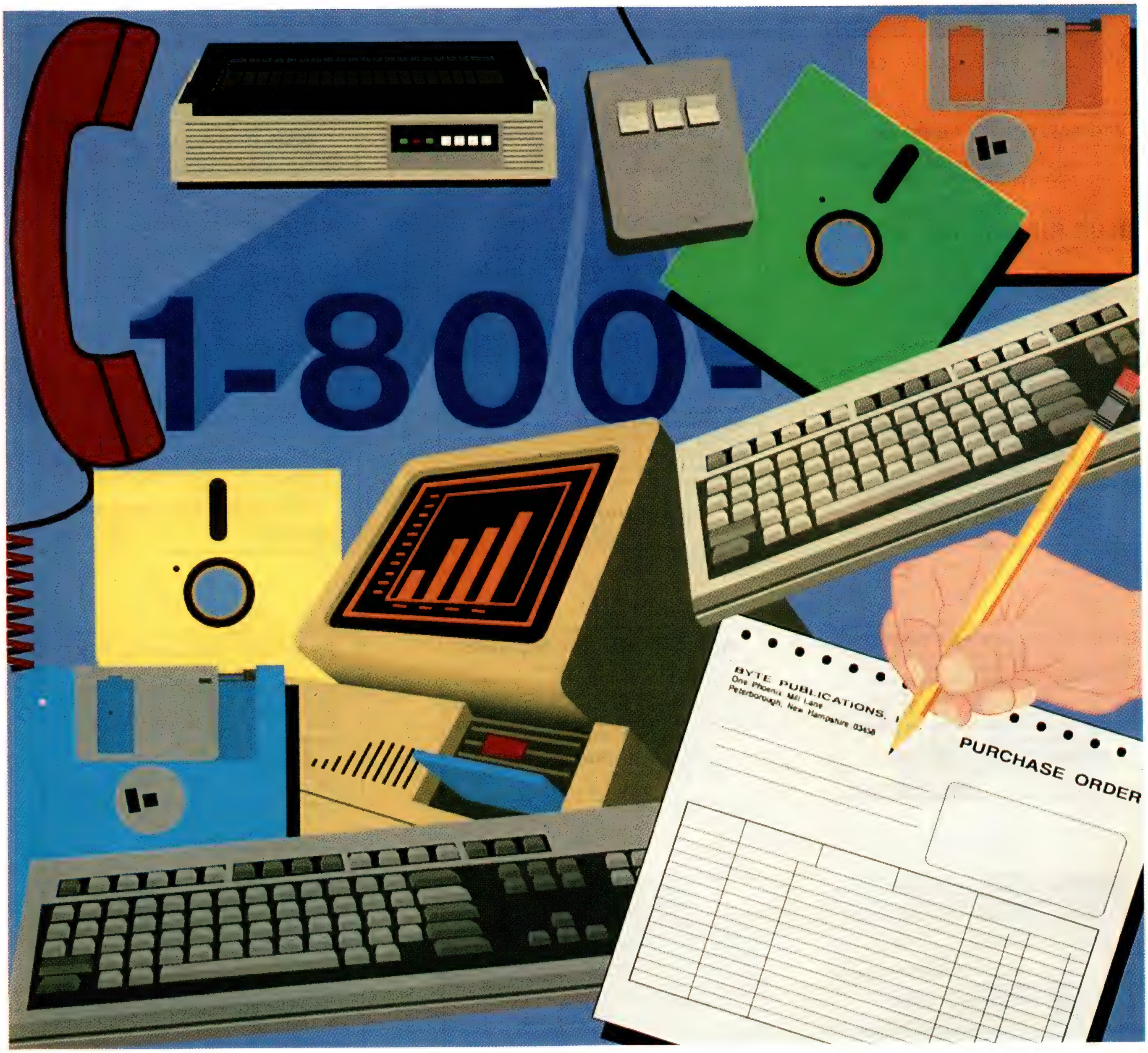

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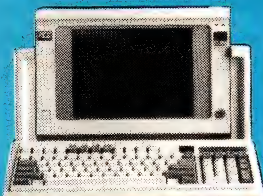

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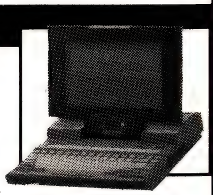

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| Logi Mouse Hi-res XT/AT | $65 |
| Masterpiece | $81 |
| Masterpiece Plus | $92 |
| MS Bus/Serial Mouse | $96 |
| MS Bus/Serial Mouse w/Windows | $129 |
| Omni Mouse II Bus w/Paint | $54 |
| Omni Mouse II Serial w/Paint | $37 |
| MS Business 5 Pack | $296 |
| PC Track Ball Serial w/Magician | $74 |
| Summa Sketch II 12x12 | $308 |
| Summa Sketch II 12x18 Pro | $559 |
| Trakman Bus/Serial | $61 |
| White Mouse Bus/Serial | $64 |

## INTEGRATIIVE

| | |
|---|---|
| Enable (OA) | $406 |
| Framework III | $434 |
| MS Works | $91 |
| PFS: First Choice | $93 |
| Smartware II w/Spell checker | $426 |

## SONY DISKS

| | |
|---|---|
| 3.5" DS/DD 100 | $88 |
| 3.5" High Density 100 | $164 |
| 5.25" DS/DD 100 | $58 |
| 5.25" High Density 100 | $98 |

## WORD PROC.

| | |
|---|---|
| AMI | $117 |
| AMI Professional | $278 |
| MS Word | $204 |
| MS Word Companion | $28 |
| MS Word for Windows | $294 |
| MS Word for Windows Upgrade | $138 |
| PFS: Professional Write | $127 |
| Volkswriter 4 | $98 |
| Volkswriter Deluxe Plus | $78 |
| Word Perfect 5.1 | $244 |
| Word Perfect Library | $68 |
| Word Perfect Office | $258 |
| Wordstar 2000 Plus | $258 |
| XyWrite III | $203 |

## XENIX

| | |
|---|---|
| MS Word Xenix | $464 |
| MS MultiPlan Xenix | $388 |
| SCO FoxBase | $664 |
| SCO Lyrix | $438 |
| SCO VP/IX | $584 |
| SCO Xenix 386 ver. 2.3.1 | $458 |
| SCO Xenix 286 ver. 2.3.2 | $414 |
| SCO Xenix 386 Complete | $1008 |
| SCO Xenix 286 Complete | $898 |
| WordPerfect Xenix 4.2 | $488 |

## COMMUNICAT.

| | |
|---|---|
| Carbon Copy Plus 5.0 | $103 |
| CompuServe Membership kit | $18 |
| Crosstalk XVI | $102 |
| Crosstalk Windows | $116 |
| Crosstalk Mark IV | $126 |
| Direct Access 4.1 | $47 |
| Fastwire II | $69 |
| Laplink III | $79 |
| Mirror III | $47 |
| PC Anywhere III | $59 |
| Procom Plus | $47 |
| Remote 2 | $102 |
| Smartcom II | $77 |
| Smartcom III | $133 |
| Smartcom 320 | $102 |
| Close-up | $117 |
| Co/session | $142 |
| Relay Gold | $157 |

## LAN & NETWRK

| | |
|---|---|
| Accpac BPI Network | $228 |
| DataEase LAN 3 pack | $439 |
| DBase IV LAN | $598 |
| FoxBase LAN | $284 |
| MS Excell Network node | $151 |
| MS Word Network node | $118 |
| Novell Netware ELS I | $410 |
| Novell Netware ELS II | $865 |
| Paradox Network | $626 |
| PFS Professional LAN | $277 |
| Q & A Network Pak (6 user) | $261 |
| R Base for DOS 1-6 Netwrk | $616 |
| Supercalc 5 LAN | $294 |
| Ventura Publisher Network | $758 |
| Word Perfect additional user | $154 |
| Xtree Networking | $208 |

## OCR

| | |
|---|---|
| Complete Hand Scan 400 | $174 |
| Complete Full Pge OCR/FP | $288 |
| CAT Reader 1/2 page | $139 |
| CAT Reader Full Page | $224 |
| DFI OCR | $64 |
| DFI OCR Deluxe | $147 |

## UTILITIES

| | |
|---|---|
| Avery List & Mail | $35 |
| I Dir Plus | $44 |
| 386 to the Max v. 3.0 | $71 |
| Above Disk | $54 |
| Backup Pro | $57 |
| Brooklyn Bridge | $66 |
| Carousel | $48 |
| Copy II PC | $21 |
| Desqview | $68 |
| Desqview 386 | $115 |
| Direct Access | $46 |
| Fastback Plus | $97 |
| Formworks w/fill & file | $98 |
| Headroom | $67 |
| Laplink III | $83 |
| Le Menu | $40 |
| Lotus Magellan | $98 |
| Mace Utilities | $52 |
| MS Windows 286 | $60 |
| MS Windows 386 | $119 |
| Move 'Em | $42 |
| Norton Commander 3.0 | $76 |
| Norton Utilities 4.5 | $62 |
| Norton Utilities Advnced 5.0 | $106 |
| PC Tools Deluxe 5.5 | $70 |
| Pop Drop 3.1 | $28 |
| Pop Drop Plus | $54 |
| Sidekick Plus | $128 |
| Spinwrite II | $66 |
| Xtree Pro | $48 |
| Xtree Pro Gold | $68 |
| Allways for Lotus | $78 |
| Allways for Symphony | $78 |
| Battery watch 2.0 | $36 |
| Bookmark Plus | $89 |
| Cruise Control | $24 |
| Dan Bricklin's Demo II | $106 |
| Go Script | $115 |
| Go Script Plus | $222 |
| Gofer | $44 |
| Lotus Metro | $52 |
| Mace Gold | $78 |
| Xtree Net | $208 |
| V Feature | $84 |
| V Feature Plus | $Call |
| Optune | $43 |

## INSTRUCTION

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|---|---|
| For the Record | $24 |
| Mavis Beacon Teaches Typing | $29 |
| PC Logo (new ver.) | $46 |
| Personal Lawyer | $34 |
| Carmen San Diego: | |
| Where in the World | $28 |
| Where in Time | $28 |
| Where in the USA | $26 |
| Resume Maker | $27 |
| Will Maker | $30 |

## LAN CARDS

| | | | |
|---|---|---|---|
| 8 bit Coax/Star | $69. | 16 bit 4 in 1 | $179 |
| 8 bit Coax/Bus | $76 | Int. 5 port Hub | $189 |
| 8 bit UTP/Star/Bus | $79 | 8 port ext Active Hub | $249 |
| 8 bit 4 in 1 | $89 | 8 port ext Active Hub UTP | $329 |
| 16 bit Coax/Star | $146 | Novell Boot ROM 8/16 Bit | $29 |
| 16 bit Coax/Bus | $154 | 8 Bit Enet Int | $164 |
| 16 bit UTP/Star/Bus | $169 | 16 Bit Hi-perf Enet Novell | $229 |

## GAME & EDUC.

| | |
|---|---|
| Battle Chess | $28 |
| California Games | $14 |
| California Games II | $31 |
| ChessMaster 2100 | $33 |
| F-15 Strike Eagle II | $33 |
| F-15 Combat Pilot | $30 |
| F-19 Stealth Fighter | $33 |
| King's Quest I, II, III, IV | $28 |
| Hunt for Red October | $29 |
| Leisure Suit Larry I | $38 |
| Leisure Suit Larry II, III | $34 |
| Mac Scuba | $48 |
| MS Flight Simulator 4.0 | $38 |
| CH Flightstick | $58 |
| PC Globe | $34 |
| PC USA | $34 |
| Red Storm Rising | $36 |
| Sim City | $28 |
| Tetris | $18 |
| Their Finest Hour | $35 |
| Tongue of the Taman | $24 |
| Tracon | $35 |
| Welltris | $18 |
| X-Men: Madness MurderWrld | $25 |

## $12 MON-ITORS

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|---|---|
| Hyundai VGA 720x400 | $299 |
| Mitsubishi Diamond Scan | $479 |
| Panasync 1391 | $499 |
| Sony 1304 Multiscan | $649 |
| Sony 1302 Multiscan | $599 |
| Sony 1320 VGA | $489 |
| NEC Multisync 2A | $498 |
| NEC Multi 3D | $599 |
| NEC 4D | $1165 |
| NEC 5D | $2095 |
| Packard Bell 12" | $89 |
| Packard Bell 14" | $110 |
| VGA (white) | $149 |
| Multisync | $399 |
| CM3 14" Multiscan 1024x768 | $439 |
| **IBM:** | |
| 8503 12" mono | $199 |
| 8512 14" mono | $479 |
| 8513 12" color | $549 |
| 8514 16" | $1169 |

# POCKET COMPUTERS $199

## BACKLIT NOTEBOOK

- ✱ 9.5 Mhz-20MB **$1295 $34**/mo only 6lbs

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**PALMTOP 80C88**, MS DOS compatible, Lotus 123 file compatible, Word Processor, Address Book, Appointment Diary, Phone Dialer, Up/Download thru parallel port to printers/ PC/XT/AT/386.0

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**PC 6220** **$79mo/**

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## TOSHIBA

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|---|---|
| T1000 786k card | $249 |
| T1000/1200 SE/XE | |
| 1MB/2MB | Call/$299 |
| T1600/3100/3200/ | |
| 5200 2MB | $295 |

## ZENITH

| | |
|---|---|
| Super Sport | |
| 1MB/4MB | $199/Call |
| Z386-20/25/33 | |
| 1MB | $145 |
| 2MB | $249 |
| 4MB | $649 |
| Z386SX | |
| 2MB | $199 |

## COMPAQ

| | |
|---|---|
| SLT 1MB | $199 |
| LTE 286 | |
| 1MB/2MB | $295/475 |
| DeskPro 286-20/20E/25/286-E | |
| 1MB/4MB | $165/440 |
| DeskPro 386S | |
| 1MB/4MB | $165/495 |
| DeskPro 386/33 | |
| 2MB | $295 |

## IBM PS/2

| | |
|---|---|
| Mdl 30/50Z/60 | |
| 512K/2MB | $75/225 |
| Mdl 70-E61/121 | |
| 1MB | $125 |
| Mdl 70 A-21 | |
| 2MB | $245 |
| Mdl 80 141 | |
| 1MB | $199 |
| Mdl 80 111/211 | |
| 2MB | $299 |
| 4019 Laser 1MB | $299 |

## HP LaserJet

| | |
|---|---|
| HP II/IID 1 | |
| 1MB/2MB | $145/209 |
| HP IIP/III | |
| 1MB/2MB | $145/245 |

## MATH COs

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|---|---|
| 386SX | $Call |
| 80287-8 | $125 |
| 80287-10 | $195 |
| 80287-12 | $204 |
| 80387-16 | $269 |
| 80387-20 | $295 |
| 80387-25 | $389 |
| 80387-33 | $455 |

## EPSON FAX

| | |
|---|---|
| F1000 | $525 |
| F2000 | $550 |
| F3000 | $699 |

## CANON FAX

| | |
|---|---|
| Fax phone 8 | $449 |
| Fax phone 15 | $419 |
| Fax phone 20 | $629 |
| Fax phone 23 | $749 |
| Fax phone 25 | $929 |
| Fax phone 35 | $865 |
| Fax 222 | $1149 |
| Fax 270 | $1495 |
| Fax 350 | $1595 |
| Fax 450 | $1845 |
| Fax 630 | $1995 |
| Fax 705 | $2479 |
| Fax 850 | $3089 |

## PANASONIC

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|---|---|
| KXF 80 Portable | $539 |
| KXF 100 | $585 |
| KXF 120 | $749 |
| KXF 220 | $1045 |
| KXF 320 | $1335 |
| KXF 50 | $CALL |
| KXF 90 | $CALL |
| KX 110 | $CALL |

## PANAFAX

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|---|---|
| UF 160 | $645 |
| UF 170 | $925 |
| PDE 120E | $495 |
| PDE 160E | $679 |
| PDE 170E | $979 |

## MURATA

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|---|---|
| M900 | $395 |
| M1400 | $528 |
| M1800 | $568 |
| M1850 | $698 |
| F25 | $769 |
| F37 | $849 |
| F40 | $1110 |
| F45 | $1299 |
| Guis 110/220v | $499 |
| Samsung 1010 | $399 |

## TOSHIBA

| | |
|---|---|
| T 3400 | $568 |
| T3600 | $659 |
| T3750 | $748 |

## RICOH

| | |
|---|---|
| RF810 | $399 |
| RF860 | $625 |
| RF910 | $579 |
| RF920 | $799 |
| Fax 15 | $715 |
| Fax 25 | $1039 |
| Fax 35 | $1099 |
| Fax 80 | $1205 |
| Fax 95 | $1795 |
| Fax 105 | $1819 |
| Fax 1010 | $2799 |
| Fax 1000L | $3095 |

## SHARP

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|---|---|
| FO 215 | $569 |
| FO 230 | $599 |
| FO 333 | $699 |
| FO 510 | $769 |
| FO 550 | $1299 |
| FO 750 | $1599 |
| FO 800 | $1995 |
| FO 5200 | $2499 |
| UX 110 | $479 |
| UX 181 | $639 |
| Audiovox 110/220v | |
| AF2000 | $499 |

## FAX CARDS

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|---|---|
| Quadfax JT 9600 | $299 |
| Hayes JT 9600 | $459 |
| 9600 FAX + 2400 Modem card | $299 |
| Complete PC 9600 | $394 |
| 9600 Fax card | $184 |

## MODEMS

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|---|---|
| 2400 int | $69 |
| 2400 ext | $Call |
| 9600 int | $395 |
| 9600 ext | $Call |

# SCANNERS

| | | | |
|---|---|---|---|
| Sharp JX 100 | $665 | Panasonic 506U | $1078 |
| Sharp JX 300 | $2779 | Panasonic 307U | $989 |
| Sharp JX 450 | $4779 | Complete PC ½ pg | $165 |
| Chinon DS 3000 | $599 | Complete PC full pg | $499 |
| Chinon DS 3000/OCR | $745 | Logitech 5" ScanMan | |
| Epson Color | $Call | + OCR | $299 |
| HP Scanjet | $1385 | DEST 8 1/2 scan + OCR | $699 |
| Oscam 400dpi full pg + | | Mars 400dpi 4" Hand + OCR | $179 |
| doc feed + OCR | $695 | Mars 800dpi 5" HandScan | |
| Panasonic 505U | $784 | + OCR | $299 |

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# LAP-TOPS

## TOSHIBA

| | | MONTHLY PAYMENTS |
|---|---|---|
| TOSHIBA T1000 | $599 | $23/mo |
| T1000 SE Notebook | | $CALL |
| T1000 XE/1200 XE Notebook | | $CALL |
| T1200 HB 20MB | $1599 | $58/mo |
| T1600 286 20MB | $2399 | $64/mo |
| T1600 286 40MB | $2585 | $69/mo |
| T1600 X 40MB | | $CALL |
| T3100 E 286 40MB | | $96/mo |
| T3100 SX 40MB/80MB | | $3585/CALL |
| T3200 SX 40MB | | $CALL |
| T5100 386 100MB | $4199 | $112/mo |
| T5200 386 40MB | $4479 | $119/mo |
| T5200 386 100MB | $4879 | $130/mo |

## SHARP

| | |
|---|---|
| PC 6220 Notebook 20MB | $79/mo |
| PC 8081 80MB Color VGA | $$169/mo |
| PC 4741 | $Call |
| PC 5741 40MB VGA | $93/mo |

## LEADING EDGE

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|---|---|---|
| 386SX with 20MB | $1995 | $52/mo |
| 386SX with 40MB | $2095 | $57/mo |

## TEXAS INSTR.

| | | |
|---|---|---|
| TI 12 286 20MB Notebk | $1895 | $51/mo |
| TI 25/45 286 | $2249/2349 | $65/63/mo |
| Notebook 286 20MB VGA–4lbs | | $CALL |

## ZENITH LAPTOPS

| | |
|---|---|
| Minisport NOTEBOOK | $Call |
| Supersport 184-2 | $1695 |
| Supersport 286 20MB | $2499 |
| Supersport 286 40MB | $2699 |
| Supersport 286E 20/40MB | $Call |
| 386SX 40MB | $3899 |

## NEC LAPTOPS

| | | |
|---|---|---|
| Ultralite 2MB NOTE BOOK | | $Call |
| Prospeed 286 20MB | $Call | $67.60/mo |
| Prospeed 286 40MB | $Call | $78.13/mo |
| Prospeed 386SX | $Call | $102/mo |
| Prospeed 386 40MB | $3499 | $92/mo |

## MITSUBISHI

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|---|---|---|
| **MP 286-210 2 FD** | $1265 | $35/mo |
| MP 286-220 1 FD, 20MB | $1639 | $45/mo |
| MP 286-240 1 FD, 40MB | $2139 | $58/mo |

## COMPAQ LAPTOPS

| | | |
|---|---|---|
| LTE 20MB | $2139 | $58/mo |
| LTE 286 20MB | $2999 | $80/mo |
| LTE 286 40MB | $3250 | $87/mo |
| COMPAQ SLT 20MB/40MB | | $Call |
| COMPAQ SLT 40MB | | $LOW |
| SLT 386SX VGA | | $Call |

## EPSON LAPTOPS

| | | |
|---|---|---|
| 286E 20MB removable | $2198 | $60/mo |
| 286E 40MB removable | $2349 | $65/mo |
| 386SX 20MB removable | $3159 | $85/mo |
| 386SX 40MB removable | $3299 | $89/mo |

## GOLDSTAR

| | | |
|---|---|---|
| GS500 286 20MB | $1495 | $40/mo |
| GS520 386SX VGA | | $Call |

## HYUNDAI

| | | |
|---|---|---|
| LT4-286 20MB VGA | | $50/mo |
| LT5-386SX 20MB | | $64/mo |
| NB-286 20MB | | $71/mo |
| Tandon LT286/LT386 40MB | | $Call |
| Panasonic CF150 B Notebk | $599 | $23/mo |
| Altima 386N SX Notebook | | $Call |

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## 386-20 Goldstar

**$1895**

40MB drive VGA monitor system • 1 year warranty • MS DOS & Alpha Works FREE

## 386SX Goldstar

**$999 $25/mo**

1MB RAM • 1 5¼" 1.2MB floppy drive • 1:1 interleave controller •

## Goldstar XT

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8 Mhz IBM XT compatible • 768K RAM • 1 5¼" 360KB FD • Color/mono card

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## Magnavox XT 20MB $599 $21/mo

8 Mhz IBM XT compatible, 768K RAM, 1 5¼" 360KB FD, Color/mono card

## 386-33Mhz

40MB mono **$1895**

## IBM PS/2

| | |
|---|---|
| Model 25 Mono/color | $975/1229 |
| IBM 8530 -286 20MB/30MB | $1695/1895 |
| IBM 8555 SX-30MB | $2695 |
| IBM 8555 SX-60MB | $3025 |
| IBM 8560 286 44MB | $3175 |
| IBM 8571E61/O61 | $3495/3895 |
| IBM 8570 A61 | $5845 |
| Portable 70 60MB/120MB | $Call |
| IBM 8570-121 20Mhz 386 | $4450 |
| IBM 8570-A21 25Mhz 386 | $6195 |
| 8580-041 16Mhz 386, 40MB | $4195 |
| 8580-111 20Mhz 386, 115MB | $5795 |

## COMPAQ

| | |
|---|---|
| Deskpro 286E 20MB/40MB | $2099/2399 |
| Deskpro 386S | $Call |
| Deskpro 386/20E 40MB | $4275 |
| Deskpro 386/20E110MB | $4799 |
| Deskpro 386/25E 84MB | $5495 |
| Deskpro 386/25E 110MB | $6195 |
| Deskpro 386/25E 300MB | $8495 |
| Deskpro 386/33 84MB | $7245 |
| **Model 486/25N** | |
| 120MB/320MB/650MB | $CALL |
| Portable III 20MB/40MB | $3395/3998 |
| Portable 386 40MB/100MB | $4799/5599 |

## APPLE MACINTOSH

| | |
|---|---|
| Portable | $3899 |
| Mac SE 30/40MB | $2950 |
| Mac IIX 40MB | $4150 |

## MORE LAPTOPS

| | |
|---|---|
| FORA 386SX with 40MB VGA | $2395 |
| **PACKARD BELL** 286-VGA20 | $1995 |
| Aris NOTEBOOK | $Call |
| PSION | $Call |
| Samsung GS 5200 | $1495 |
| Bondwell 310: 286 40MB | $1695 |

## PRINTERS

| | |
|---|---|
| Panasonic KXP-1180 | $169 |
| Panasonic KXP-1191 | $209 |
| Panasonic KXP-1124 | $289 |
| Panasonic KXP-1695 | $Call |
| Panasonic KXP-1624 | $Call |
| KXP-4420 LASER | $Call |
| KXP-4450i LASER | $1299 |
| KXO 4455 LASER | $Call |
| Diconix 150 plus | $318 |
| Diconix 300 | $345 |
| Sharp Laser SX-9500 | $895 |
| NEC 2200 | $325 |
| NEC 5200 | $498 |
| NEC 5300 | $649 |
| Okidata ML 182 | $230 |
| Okidata ML 320 | $335 |
| Okidata ML 321 | $455 |
| Okidata ML 380 24 pin | $355 |
| Okidata ML 390 24 pin | $455 |
| Okidata ML 391 24 pin | $619 |
| Okidata ML 393 24 pin | $959 |
| Okidata ML 393C 24p | $1029 |
| Okidata ML 2410 24p | $1595 |
| Toshiba 301 | $318 |
| Toshiba 311 | $409 |
| Page Laser 6 | $1099 |
| HP Deskjet Plus | $695 |
| HP 2P Laser printer | $969 |
| HP III Laser printer | $1565 |
| HP 2D Laser printer | $2399 |
| HP Deskwriter | $795 |
| Epson LQ510 | $295 |
| Epson Laser 6000 | $899 |
| Epson FX1050 | $325 |

## HARD DRIVES

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|---|---|
| Conner 40MB 25ms | $349 |
| Conner 100MB 25ms | $599 |
| Conner 200MB 18ms | $945 |
| **SEAGATE** | |
| 20MB ST225 | $189 |
| 30MB ST238R | $199 |
| 40MB ST251-1 | $259 |
| 60MB ST277R | $249 |
| 80MB ST4096 | $539 |
| 20MB ST125 3.5" | $238 |
| 30MB ST139 3.5" | $258 |
| **WESTERN DIGITAL** | |
| WD 1003V-MM1 HDC | $89 |
| WD 1003V-MM2 HDFDC | $99 |
| WD 1003V-SR1 RLL | $99 |
| WD 1003V-SR2 RLL | $115 |
| WD 1006V-MM1 1:1 | $99 |
| WD 1006V-MM2 HDFD | $119 |
| WDXT-GEN2/XT HDC | $58 |
| Filecard 20MB XT/AT | $349 |
| WD 3.5" 40MB IDE AT | $415 |

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| | |
|---|---|
| PS/2 model 30/286-30 meg | 1795 |
| PS/2 model 50Z/286-60 meg | 2395 |
| PS/2 model 55SX/386SX-60 meg | 3295 |
| PS/2 model 70/386-120 meg | 5595 |
| PS/2 model 80/121-120 meg | NEW |

*** Monitor Extra ***

**COMPAQ**

| | |
|---|---|
| Compaq 286E-40 meg | 2150 |
| Compaq 386/20E-100 meg | 4150 |
| Compaq 386S-100 meg | 3595 |
| Other Models | CALL |

*** Monitor Extra ***

**Macintosh**

| | |
|---|---|
| Mac SE/30-40 meg | 3195 |
| Mac-IICX-80 meg | 4595 |
| Mac Portable-40 meg | 4795 |
| Other Models | CALL |

*** Keyboard & Monitor Extra ***

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## LAPTOP

| | |
|---|---|
| Compaq LTE/286-20 | 2975 |
| Sharp 286/40 | 2490 |

CALL FOR OTHER BRANDS

## LAPTOP ACCESSORIES

| Memory | |
|---|---|
| 1 meg Toshiba 1000SE | 325 |
| 2 meg Toshiba 3100SX | 390 |
| 2 meg Toshiba 3200SX | 399 |
| 2 meg Toshiba 5200 | 415 |
| 1 meg Compaq SLT | 390 |
| Modems | |
| 2400 Int. for Laptops | 225 |

**EVEREX**

**Everex System 1** **1995**
Everex Step 286/12 - 1meg
40 meg VGA card and monitor

**Everex System II** **2495**
Everex Step 386SX - 2 meg
40 meg VGA card and monitor

**Everex System III** **5395**
Everex Step 386/33 - 4 meg
150 meg VGA card and monitor

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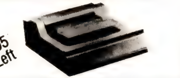
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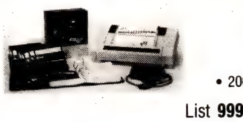

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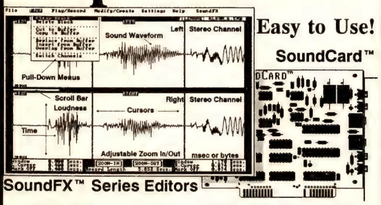

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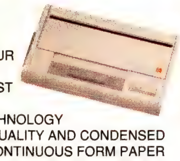

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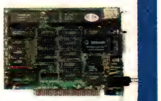

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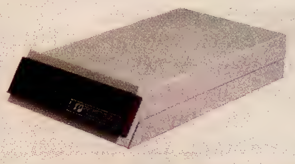

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memory, 64K-byte segments, and 16-bit registers: an 8086, in fact. Intel intended this impoverished mode to be used solely for initialization of the 386's native protected mode. In protected mode, the programmer sees the 386 as it truly is: a machine with potentially multiple gigabytes of memory, segments of up to 4 gigabytes, and 32-bit registers.

In 1986, Intel stated that "most applications of the 386 will use real mode for initialization only," and in 1989 it stated that "the primary purpose of real mode is to set up the processor for protected-mode operation." But in fact, most applications of the 386 use real mode exclusively, because the 386 is largely used to run old 16-bit MS-DOS software.

This strategy is like buying a top-of-the-line sound system and then using it to play only old 45s or 78s. DOS applications that run on the 386 were designed with a 640K-byte memory limitation and a 64K-byte segment limitation. These limitations do not disappear when these applications run on a 386; the programs just get around the limitations faster. For example, many naive users are astonished when, after adding 2 MB of memory to their 286 or 386 computer, all their DOS applications are still limited to 640K bytes. These users are right to be astonished. The 386 has 32 address lines to memory, allowing access to $2^{32}$ bytes (more than 4 gigabytes) of memory, but when it runs in 16-bit-emulation mode, all address lines above $2^{20}$ (1 MB) are masked out. Techniques such as bank-switched expanded memory work around limitations that the 386 is only emulating—that is, only *pretending* to have. Such insanity is the price of using the 286 and 386 as fast XTs.

Eliminating these simulated limitations requires retargeting an application for protected mode, thereby junking 8088 compatibility. More and more applications can afford to lose this backward compatibility.

## Large Memory

What does this retargeting entail? Most programs ported to run in 32-bit protected mode will probably be fairly large, since the primary benefit of using a DOS extender is gaining access to more memory than is available under plain-vanilla DOS. I can't present a realistic large program in the context of this article, but, to illustrate some of the mechanics of working with a DOS extender, I can use a small program that allocates a lot of memory.

Listing 1 shows MEM.C, a tiny program that runs the C memory allocation function `calloc()` in a loop, allocating all available memory. If you compile this program for real-mode MS-DOS using compact model (which is perfect for this tiny amount of code that manipulates a large amount of memory) and run it on a Compaq 386 with 4 MB of memory, the program allocates 525K bytes. It is oblivious to most of the memory in the machine (see table 1).

*Most applications of the 386 use real mode exclusively, because the 386 is largely used to run old 16-bit MS-DOS software.*

You can compile this real-mode version with Microsoft C 6.0, for example, using the command line `cl -AC mem.c`. The `cl` driver program first runs the C compiler and then runs the Microsoft linker to produce an executable program, MEM.EXE, which can then be run from the DOS command line.

Unfortunately, you can't use standard C compilers for MS-DOS to produce a 386-specific version of this program. While Microsoft C provides the `-G2` option to generate 286-specific code, it doesn't have an equivalent `-G3` switch. In a compiler producing code for real mode, this hypothetical `-G3` switch could only use 386-specific instructions and perhaps the 386's 32-bit registers. Without protected mode, it couldn't use the 386's large address space.

To produce a true 32-bit protected-mode version of the program in listing 1, you need a 32-bit C compiler (e.g., MetaWare High C or Watcom C/386). However, you don't need to change the source code. For Watcom C/386 7.0, you would use the command line `wcl386 -mf mem.c`. This compiles for the 386 flat memory model, in which the program is given a single segment analogous to the "tiny" model in the 8088 world (.COM files), except that the maximum size for the one segment is 4 gigabytes rather than 64K bytes. With the MetaWare High C 1.6 compiler (whose target code runs under what MetaWare calls "MS-DOS 386/486"), you would use the command line `hc386 mem.c`. In both cases, the driver programs first run their respective C compilers and then run the Phar Lap linker (386|LINK.EXE) to produce a 32-bit protected-mode executable, MEM.EXP (the file extension .EXP generally indicates a protected-mode executable).

On the same Compaq 386 with the same source code, the resulting program now allocates 2.9 MB of memory (see table 1). Although the nearsighted real-mode version will always be stuck at around 525K bytes regardless of how much memory you add to the machine, the 32-bit protected-mode version will actually use any memory that you added to the machine.

In contrast to EMS and the Extended Memory Specification (XMS), which require programs to access extra memory indirectly, a program using a DOS extender can use a normal `malloc()` or `calloc()`, pointer dereference `(*p)` and array indexing `(p[size-1])` to access memory. The distinction between conventional memory and other memory disappears. This transparent access to large amounts of memory alone makes protected-mode development enticing.

## Running Protected-Mode Programs Under MS-DOS

But how can you run this .EXP file under MS-DOS? That's the job of the DOS extender itself. For example, Phar Lap's 386|DOS-Extender is actually an executable file, RUN386.EXE. RUN386 re-

*continued*

**Listing 1:** *A sample program that allocates all available memory.*

```
/* MEM.C */
/* syntax: mem [count] [size] */

#include <stdlib.h>
#include <stdio.h>

main(int argc, char *argv[])
{
    unsigned long allocs = 0;
    unsigned count = (argc > 1) ?
          atoi(argv[1]) : 1;
    unsigned size = (argc > 2) ?
          atoi(argv[2]) : 1024;
    char *p;

    while (p = calloc(count, size))
    {
          *p = 'x';
          p[(count * size)-1] = 'x';
          if (size >= sizeof(unsigned long))
              *((unsigned long *) p) = 0x12345678L;
          allocs++;
    }

    printf("%lu allocs: %lu bytes\n",
          allocs, allocs * count * size);
}
```

**Listing 2:** *Peeking at the BIOS timer count.*

```
/* TICKS.C */

#include <stdio.h>

main( )
{
      printf("ticks: %lu\n",
            *((unsigned long far *)
            0x46CL));
}
```

is the benefit to using a 386-based (32-bit) rather than a 286-based (16-bit) protected-mode DOS extender?

An optional command-line argument to the MEM demo program shows one benefit of using a 32-bit DOS extender. By default, MEM allocates memory in 1K-byte blocks. Providing a command-line argument helps you determine the largest block of memory that can be allocated at one time:

```
C:\>mem 63
7 allocs: 451584 bytes
C:\>mem 64
0 allocs: 0 bytes
```

Even though a 286-based DOS-extender version of MEM can allocate megabytes of memory, it suffers from the real-mode inability to use 64K bytes or more at a time. This is an inherent limitation of 16-bit code: Since the CPU registers are used to hold offsets in memory segments, and since the largest possible 16-bit number is FFFFh (64K bytes), it follows that the largest addressable segment in 16-bit mode is 64K bytes. This 64K-byte barrier is at least as important as the better-known 640K-byte limitation of DOS. A workaround, known as *huge model*, is available for real mode and 16-bit protected mode, but it can seriously reduce program performance. It is particularly tragic to use this when using a 386, since, again, it gets around a merely simulated limitation.

The 386 is a 32-bit CPU. While PC programmers are familiar with 16-bit registers like BX, BP, and IP, the 386's registers are 32 bits wide and have names like EBX, EBP, and EIP. When 16-bit software is run on this 32-bit CPU, the top half of the registers are inactive. Therefore, programs suffer from the same 64K-byte limitation as a 286 or even an 8088 has. But if you use the 386's 32-bit registers in protected mode, then the largest possible offset is FFFFFFFFh (4 gigabytes); it is limited only by the amount of memory actually present. For example, you can allocate memory in 1-MB blocks without resorting to kludges (e.g., huge model):

```
C:\PHARLAP>run386 mem 1024
2 allocs: 2097152 bytes
```

It is useful to examine the assembly language output from a 32-bit C compiler (shown in table 2) to see how the pointer dereferencing `*p` and `p[(count * 1024) -1]` works. With registers such as ESI to form offsets into memory, it is clear that you can generate enormous offsets—so enormous that, in fact, you only need one segment. Notice the absence of any reference to segments in the 32-bit code in the table: We are working in a Motorola-like linear address space. Note how 32-bit quantities can be handled in one fell swoop, rather than piecemeal. Finally, note how the return value from `calloc()` appears in the EAX register rather than in a register pair such as DX:AX. This is what is meant by 32-bit code.

In contrast, the 16-bit output from even a fine compiler like Microsoft C is positively grisly, as shown in table 2. All 32-bit quantities (e.g., the far pointer returned in DX:AX by `calloc()`) are handled 16 bits at a time. No segment can be greater than 64K bytes, and since you will then need a lot of segments, you need to use the LES instruction and the ES: override prefix. All this happens even when this code runs on a 386, which has perfectly good 32-bit registers just waiting to be used.

The key to a 32-bit compiler's advantage over a 16-bit compiler is that `sizeof(int)` is 4, not 2. Likewise, `sizeof (void near *)` is 4, not 2. This means that it can handle much larger quantities with "simple" types and that, conversely, large quantities only require the use of a "simple" type. This becomes clear in table 3, in which an assignment involving an `unsigned long` needs two MOVs in 16-bit code, but only one MOV in 32-bit code. In addition, the 386 allows far more regular use of registers for addressing: Whereas earlier Intel processors only allowed the use of the base (BX and BP) and index (SI and DI) registers for addressing, registers such as [EAX] are legal on the 386.

Note that you can use some of the features of the 386 in real mode. For example, the 32-bit code (`mov dword ptr [eax], 12345678h`) shown in table 3 is perfectly legitimate in real mode, as long as EAX is less than FFFFh. You can use small assembly routines, or in-line assembler with a compiler such as Turbo C, to take advantage of some 386-specific features in real mode.

There is one interesting sidelight to the 4-byte near pointers such as [EBX] used in 32-bit protected mode: A far pointer such as ES:[EBX] is a 6-byte quantity. The expression `sizeof(void far *)` evaluates to 6 in a 32-bit C compiler, but, since such an FWORD PTR is an unusual quantity in C, some compilers manipulate these pointers awkwardly. For example, the DOS-specific macro MK_FP(), which forms a far pointer from a segment and an offset, is tricky to implement. Fortunately, with flat models and offsets as large as FFFFFFFFh, segments are never used for normal addressing, so neither are far pointers. However,

*continued*

exist but seem not to, the word *virtual* refers to things that seem to exist but don't. The 386 provides a V86 mode that creates the illusion of an 8086 machine located in an arbitrary place in the 386 address space. The 386's segmentation and paging provide hardware assistance for virtual memory; this allows it to pretend that it has more memory than is physically present.

While V86 mode is generally used by multitaskers such as Desqview and Windows or memory managers such as 386-Max or QEMM, Ergo's OS/386 makes a novel use of V86 mode. It uses it as a quick-and-dirty way to provide simple DOS applications (normally limited to something less than 640K bytes) with several hundred kilobytes more memory. Ergo's up program, which runs .EXP files, can also run real-mode .EXE files. As table 1 shows, when up runs under OS/386 in this configuration, the real-mode MEM program now allocates 617K bytes.

OS/386 also provides a utility called `giveameg`. When this utility runs on simple programs like MEM, it can provide up to 1 MB of memory in V86 mode. (This only works on the 386.) Because the resulting program isn't really running at the memory location that it thinks it's running at, this technique won't work if you need to address absolute memory locations such as B8000h or 400h. But compilers and other `stdio` text processors may find that the few hundred extra kilobytes can be quite handy. This technique just takes a real-mode executable and runs it in a funny way. To take full advantage of the 386, though, you have to switch to a 32-bit compiler.

Something that at first seems like a free lunch is virtual memory. Both Phar Lap and Ergo provide VM options for their 32-bit DOS extenders. From table 1 you can see that, on the same machine with 4 MB of memory, and with the same source code (and, in fact, the same MEM.EXP), the tiny program can allocate 13 MB of memory when it runs under VM. The 13-MB limit was merely the amount of free disk space I had.

For Ergo OS/386, using VM requires installing the `os386vm` TSR instead of `os386`. By default, this uses "only" 8 MB of VM (i.e., disk space), but you can reconfigure it. The 386|VMM option to Phar Lap's 386|DOS-Extender is a protected-mode executable, VMMDRV.EXP, which you can bind into your executable or, during development, run on the DOS command line: `run386 -vm vmmdrv.exp mem`.

While this shows that you can use VM without a program's knowledge and without any source code changes, almost all genuine programs that use VM require some recoding to get decent performance. For example, if a program allocates 13 MB of memory (of which only 3 MB is physical memory), and if the program frequently loops over, say, 4 MB at any one time, the program will thrash horribly. To be usable, the program would need to be tweaked until its "locality of reference" fell within 3 MB.

**TWO VERSIONS OF THE DOS WRITE FUNCTION**

**Table 4:** *DOS extenders alter the normal DOS protocol; the source buffer can hold 4 gigabytes of data.*

**Real-mode MS-DOS**
Int 21h function 40h
Write file or device
BX = handle
CX = number of bytes to write
DS:DX = segment:offset of buffer

**32-bit protected-mode DOS extender**
Int 21h function 40h
Write file or device
BX = handle
ECX = number of bytes to write
DS:EDX = segment:offset of buffer

> *Something that at first seems like a free lunch is virtual memory.*

### Protection Violations

So far, I haven't described anything resembling the sort of work you might expect when porting code to a new environment. Unlike OS/2, for example, which presents an entirely new world view, DOS extenders try to preserve as much of your old source code as possible. Their relationship to MS-DOS is somewhat like that of early DOS to CP/M. The use of INT 21h is, of course, the prime example: 32-bit protected-mode operations have been made to look like plain-vanilla DOS operations.

But for most commercial DOS applications, the MS-DOS application programming interface does not consist entirely of INT 21h calls, or even of BIOS calls such as INT 10h or INT 13h. In reality, the DOS API includes the following: absolute memory locations, port addresses, undocumented DOS calls and data structures, interrupt handlers, DOS extensions (e.g., the mouse or NetBIOS), and even the vagaries of real mode itself (e.g., a segment ID corresponds to its absolute physical address divided by 16). Such code may represent less than 5 percent of all code in a real DOS application. Some of it may have been written to get around the 640K-byte or 64K-byte DOS barriers, so you can simply ditch it when you work in 32-bit protected mode. But what about graphics code, interrupt handlers, and telecommunications or networking code? How can you make such low-level code work in 32-bit protected mode?

Most of the work in porting to protected mode will be confined to small portions of your code. The best way to proceed with such a port is to get all your modules to compile and link for 32-bit protected mode and then try to run the thing. The chances are good that the program will, in some way, break one of the rules of protected mode. Because of these rules, protected mode is sometimes regarded as an unfair and stern task master, forcing you to change all your programming habits in exchange for extra megabytes of memory. In fact, you should look on protected mode as a friend that will help you incrementally port your program. Because of protection, it's fairly difficult to crash the machine. Instead, you just run your program until it violates protection, fix the problem, and then let the program run until it hits the next protection violation. The CPU itself, running in protected mode, will find most of your problems for you.

What does a protection violation look like? For an example, look at TICKS, the

*continued*

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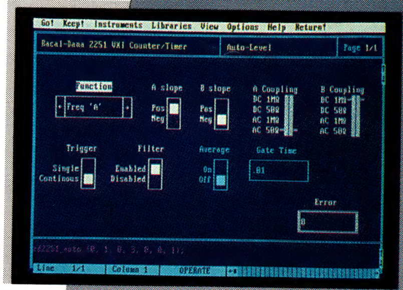

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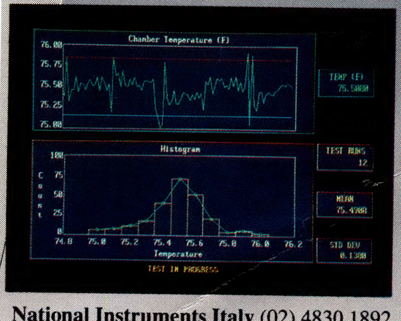

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